Appendix A

Detailed Submission Responses

Advisian
WorleyParsons Group

Queensland Government

Responses to unique submissions

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. The full wording of submissions is not used for the purposes of brevity and readability.	Response
1	Hugh Lavery *Member of the public*	1. Importance of Caley Valley Wetlands for waterbird populations in the Bowen-Ingham coastal complex of wetlands.	Refer to Section 0
		2. Wetland enhancement - concerns that the current proposal does not offer the most effective solution to conservation of the wetland. It is suggested that strategic placement of dredged material can be used to create offsetting wetlands, in a similar fashion as was undertaken by the Bowen Gun Club.	Refer to Sections 0 and 4.1.2.8 There is no predicted significant impact from the Project on the Caley Valley Wetlands; therefore no wetland offset actions are warranted. While the historical bunds currently allow for water to pond when rainfall is sufficient to fill the wetland, providing ideal migratory shorebird and other waterbird habitat, there are negative impacts associated with these bunds for the condition of the estuarine ecosystem.
		3. Submission makes reference to several attachments from the Queensland Department of Primary Industries regarding migratory bird species and waterfowl.	Noted, not material to the conclusions drawn in the draft EIS assessment.
2	Mackay Conservation Group *Community / conservation*	1. Groundwater a. Clarification needed for directions of groundwater flows and displacement of additional existing saline groundwater into the Abbot Point Caley Wetland	Refer to Section 4.1.2.6 and 4.1.2.4

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2 cont.	*group*	aggregation.	
		b. How reliable are the hydraulic conductivity values used in the groundwater model?	Refer to Section 4.1.2.6
		c. Clogging of sand pores below the DMCP, and associated threats to the wetland, have not been taken into account in the groundwater assessment. d. Groundwater mounding - how will varying rates in the height of the groundwater mound that will develop from the wastewater seepage affect the rates of groundwater flow from the DMCP to the wetland? The fluxes to the wetland should be assessed. e. Salinity modelling - the estimation of salt transport is potentially misleading, and findings and assumptions should be reviewed. In particular there needs to be stronger wording around caution and explanation in this section, to highlight that none of the predicted salinities could be considered as potentially real world values. f. Seasonal changes in groundwater levels - how is this variability incorporated into the groundwater modelling?	Clogging of pore spaces will effectively lower the permeability of the underlying layer or sediment, which in turn will reduce the volume of DMCP seepage into the underlying aquifer. The model does not account for this occurring, rather it assumes there is no change to hydraulic properties of the underlying sediments. This approach provides for a conservative assessment of impact from seepage into the underlying aquifer, rather than underestimating this potential seepage. The impact from groundwater mounding resulting from the DCMP operation is described in Section 6.8 of the Groundwater Assessment Report (Volume 3, Appendix L) and in Section 4.3.4 of the draft EIS (Volume 2). Specifically, the variation in the height of this mounding is discussed by assessing three different climate scenarios (dry, average and wet climate conditions), which are the mechanisms that will produce this variability in groundwater mounding. The DMCP is assumed to remain at full supply (operating) level for the duration of dredging. Seepage fluxes

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2 cont.		g. Makes reference to attachment: review of Groundwater Assessment report, author: Dr Adrian Werner (Flinders University)	reporting to the wetland are described in Section 6.8.5 and Section 6.8.6 of the Groundwater Assessment Report (Volume 3, Appendix L). The objective of the salinity modelling was to identify the extent (magnitude) of additional salinity loading likely to result from the DMCP operation. Due to the complexity of the salinity profile within the underlying groundwater system and limited information on the groundwater regime of the broader surrounds, i.e. beyond the area of detailed investigations (T2, T3 and wetlands areas), a simplified salinity modelling approach was adopted to predict transport of saline seepage from the DMCP. The model focusses on Layers 1 to 4, which are considered to be those that comprise brackish to saline groundwater. The underlying layers are not considered in this model on the basis that these include the more dense hypersaline groundwater. A uniform, initial concentration value of 5,000mg/L was assigned across the model domain at the start of dredging, assumed to be in the dry season. The salinity modelling therefore predicts the change in the existing groundwater salinity (5,000 mg/L) resulting from seepage of saline (seawater, 35,500mg/L) to hypersaline water (up to 70,000mg/L, evaporative concentration within the DMCP). The model used existing climate data (rainfall and evaporation) as a

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2 cont.			recharge boundary applied across the entire model domain to represent seasonal changes in groundwater levels. In addition, three climate conditions were run to represent groundwater responses to varying climate extremes, i.e. periods of low, average and high rainfall conditions.
		2. Sensitivity analysis - there has been no sensitivity analysis on the aquifer parameters.	Refer to Section 4.1.2.4 Sensitivity analysis was undertaken and is documented in Section 6.10 of the Groundwater Assessment Report (Volume 3, Appendix L).
		3. Acid Sulfate Soils – risk of ASS to be dealt with by addition of neutralising agents. How will resulting higher alkalinity of the groundwater affect the pH range and ecology of the T1 area and the wetland? Makes reference to attachment which examines ASS of the project proposal authored by Richard Bush (Southern Cross University)	Refer to Section 4.1.1.4
		4. Beneficial use of dried spoil sediments – these sediments would be highly saline and could not be used in areas of lower salinity because salt would leach into the surrounding environment. This risk is unacceptable given the international significance of the adjacent wetland.	Salinity of the dredged material will reduce over time while stored such that the material will not be an ongoing source of salt. This will enable its reuse without risks of environmental impacts.

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2 cont.		5. Pond design – the water budget and pond design for the site needs to be designed to account for all the high wet season rainfall, as well as the changes in hydraulic head in the seepage ponds caused by changes in dredge pumping rates both in and out of the ponds and reduced recharge rates caused by clogging of the groundwater sand pores.	Refer to Section 4.1.1.3
		6. Fauna a. Concerns that habitat fragmentation from loss of 75ha of vegetation will impact on the Squatter Pigeon. b. Koalas occur at Abbot Point, and need to be considered. c. More bird surveys need to be done to identify where and when and which species can be present in internationally significant numbers under different rainfall amounts, which vary from year to year.	The 75ha of habitat that will be impacted as a result of the location of the DMCP is predominantly cleared pasture land and no Squatter Pigeons have previously been recorded within the project footprint. The species has been recorded in small numbers in the Abbot Point area and the species is neither rare nor disjunct from the broader population. Cleared pasture land is the most common habitat type in the region, and the loss of 75ha of cleared land within an area that is not considered to represent important habitat for the species would not result in a significant residual impact on the species. There is no habitat suitable for Koala in the onshore project area (ELA, 2015) and the construction of the DMCP and pipelines will not impede movement for Koalas between habitats suitable for the species. The need for additional surveys is discussed in Section 4.1.2.4. Further surveys of the wetland are not considered necessary, as the

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2 cont.			results would be highly likely to confirm the findings of the draft EIS that the wetland fringe is of value to shorebirds (some in internationally-significant numbers) and that this is to be managed accordingly.
		7. Wetland - it is considered that the proposal contravenes the obligations of the RAMSAR agreement and its designation on the Caley Valley Wetlands congregation.	Refer to Sections 0 and 4.1.2.8
		8. Marine ecology / hydrodynamic modelling	Refer to Section 4.1.2.2
		a. Mapping of coral reefs adjacent to the site is incorrect, and needs to take into account additional sites identified as a result of local knowledge. Plume modelling results indicate these additional areas may be impacted by dredge plumes. *Provides coordinates for a number of coral reefs.*	
		b. Shipping – sediment plumes associated with additional vessel movements have not been properly considered (including berthing, releasing, sailing, and anchoring activities).	Refer to Section 4.1.2.12 Refer to Section 4.1.2.1
		c. Oil and other residue pollution from heavy ships has not been adequately addressed.	Refer to Section 4.1.2.12

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2 cont.		9. Coal dust – impacts of coal dust on adjacent wetlands and the GBR from coal dust are not properly understood.	The Project will not result in any direct emission of coal dust. However, it is acknowledged that the impacts of the associated T0 project will include impacts in related to coal dust emissions. These impacts are noted in the Air Quality Technical Assessment (Volume 3, Appendix Q - Section 6.2) and discussed in detail in the T0 EIS (CDM Smith, 2013a).
		10. Air quality – emissions associated with bare surfaces caused by the DMCP and areas of potential contaminated land have not been adequately assessed.	The draft EIS and specifically the air quality assessment (Volume 3, Appendix Q) assessed the air quality impacts of construction and operational activities including bare surfaces. A Preliminary Site Investigation (Volume 3, Appendix G) has been undertaken and is considered adequate for the draft EIS. The assessment identified potential for contaminated land. The Proponent has committed to undertaking a detailed site investigation and appropriate remediation (where required) prior to any construction ground disturbance in these areas.
3	Detailed individual submissions appended to the AVAAZ campaign	1. General issues regarding opposition to Carmichael Mine, contribution to climate change, and financial status of Adani.	Refer to Sections 4.1.1.1 and 4.1.2.10
		2. Impacts on endangered wildlife - the waters around Abbot Point where dredging will take place are home to rare and endangered sea turtles, Dugongs, Snubfin Dolphins; and in the path of migrating Humpback Whales. Many of these	Refer to Sections4.1.2.1 and 4.1.2.5 Section 4.1.3.2 of Appendix Q1 (Volume 3) discusses the Australian Snubfin Dolphin, particularly through the following:

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3 cont.	submission *Member of the public*	animals, including Dugongs and turtles, depend on the seabeds which will be dredged for their supply of food. Dredging in this area will also create a muddy plume that could spread for many kilometres, potentially affecting the marine park and nearby coral reefs.	***Importance of Abbot Point inshore dolphin populations and habitat*** *There are no population estimates for either the Australian Snubfin or Indo-Pacific Humpback Dolphin within the project area, nor are there any confirmed national estimates for the two species. Studies of Queensland coastal locations (as discussed above) including Townsville, Gladstone/Port Alma and the Great Sandy Strait have indicated that:* ▪ *Populations of these species are generally small, usually with less than 100 individuals in any one location* ▪ *Recent studies indicate that these small populations can be relatively disconnected due to geographic isolation and genetic separation* ▪ *Studies indicate that both species show a level of site fidelity, with evidence of female philopatry in Indo-Pacific Humpback Dolphins* ▪ *There is currently very little published information on the scale of movement between habitats and between regions along the coast.* *Detailed studies have not been undertaken within the project area to determine whether these population characteristics are also true for the Australian Snubfin and Indo-Pacific Humpback Dolphins observed at Abbot Point. In the absence of such information, a*

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3 cont.			*precautionary approach needs to be applied and populations of both dolphin species at Abbot Point need to be considered as potentially disconnected, small (<100) and potentially genetically distinct. The conservation importance of Australian Snubfin and Indo-Pacific Humpback Dolphins in a local context should therefore be considered as high.* ***The lack of regional and national population data for both species, however, makes it difficult to understand the importance of the population of Australian Snubfin and Indo-Pacific Dolphins in a broader context. In terms of the impact assessment of the Project on these species, it is assumed the population of Australian Snubfin and Indo-Pacific Dolphins at Abbot Point may be important and management and mitigation measures put in place will ensure the residual impact on these species from project activities is low*.”**
		3. The impacts on the Caley Valley Wetlands - these wetlands are of international importance for birdlife, supporting up to 40,000 waterbirds including many rare and threatened species. Dumping dredge spoil near them risks overflow, sediment spread and contamination. Wastewater will almost certainly infiltrate the delicate wetlands.	Refer to Section 0
		4. Risk of disturbing ASS - the seabed sediments in the area	Refer to Section 4.1.1.4

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3 cont.		that will be dredged are known to contain PASS. These soils can become very acidic when exposed to air.	
		5. Impacts of increased shipping - there are currently around 174 ship visits to Abbot Point. With the construction of T0, this is expected increase by 560 ships at full capacity. This vastly increases risk of reef damage from ship wreck and pollution.	Refer to Section 4.1.2.12
		6. Risk of cyclones and floods - the DCMPs will be on a low-lying coastal plain adjacent to the coast in a tropical area prone to cyclones. The risk of flooding and overflows during heavy wet season rains, storms or cyclones is high. Any overflow from the ponds will flow directly into the wetland.	Refer to Section 4.1.1.3
4	Namoui Pty Ltd and AR & EJ Curteis *Commercial fishers*	1. Concerns that Fisheries Resource Assessment does not completely account for the quantity of catch nor effort undertaken in the relevant grid squares. Makes reference to a number of attachments around fishing records at Abbot Point, commercial fishing offsets, and minutes of the Abbot Point Working Group	Refer to Section 4.1.2.13
		2. Concerns that findings of the Fisheries Resource Assessment in relation to additional shipping on fishing activities do not accurately represent true impacts.	Refer to Section 4.1.2.13

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4 cont.		3. Effect of seagrass loss and impacts to benthic habitat, and their associated effects upon fisheries resources are not accurately portrayed.	Refer to Sections 4.1.2.3 and 4.1.2.13
5	Australian Marine Conservation Society / World Wildlife Fund *Community / conservation group*	1. Project need - the Project should not be commenced until final approvals or financial close for the developments driving this expansion (namely coal mining operations and related rail infrastructure from the Galilee Basin in Western Queensland) are achieved.	Refer to Section 4.1.1.1
		2. Project alternatives – a more thorough assessment of alternatives is required.	Refer to Section 4.1.1.2
		3. Project design a. Having unlined pond floor represents a higher risk to adjacent receiving environments, and should be reviewed. b. No specification of timing of construction of DMCP or dredging - concerns that these activities may be undertaken during periods when impacts to wetland and adjacent marine ecosystem may be greater.	Refer to Sections 4.1.1.3 and 4.1.1.5
		4. Contaminated land – more detailed contamination investigation is required to clarify extent of contamination.	Refer to Section 4.1.1.4

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5 cont.		5. Groundwater – it is considered that an in-depth, independent expert review of the groundwater modelling is required, as there are a range of issues that may render modelling results in accurate. Makes reference to attachment: review of Groundwater Assessment report, author: Dr Adrian Werner (Flinders University)	Refer to Section 4.1.2.4
		6. Surface water – stormwater release from DMCP (after dewatering) and potential lateral seepage (under sidewall liners) will be discharged to designated release points, which may result in impacts to the wetland. It is considered that any associated impacts have not been adequately addressed in the EIS.	The Proponent considers that potential impacts on the Wetland associated with stormwater release and lateral seepage from the DMCP have been adequately considered in the EIS. Refer to Section 4.1.1.3
		7. Birds a. The assessment of impacts to bird species is based on survey data that is considered inadequate, and therefore does not assess potential impacts satisfactorily.	The adequacy of additional bird survey data is discussed in Section 4.1.2.4.
		b. Shorebirds' ability to migrate and/or breed may be affected by flight responses to Project-related noise. The EIS should specify when project activities are permitted, to avoid breeding and resting periods of shorebirds.	Refer to Section 4.1.2.8

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5 cont.		8. ASS and other contaminants a. The testing of ASS across the footprint for the containment ponds is unable to reliably predict if ASS is present or not, due to the method of testing having known limitations and inadequate sample numbers. b. The testing of ASS associated with the material to be dredged as part of T0 is inadequate to determine the suitability for land based disposal, due to the inadequate sampling regime, and the uncertainty around the self-neutralising capacity of the material. c. Other issues which may occur irrespective of the acidity impacts such as deoxygenation impacts, iron plumes, altered soil nutrient leaching and elevated mobilisation of metal contaminants, have not been adequately addressed. d. It is also noted that contaminants identified in previous projects are not being included in the current EIS. Makes reference to attachment which examines ASS of the project proposal authored by Richard Bush (Southern Cross University).	Refer to Section 4.1.1.4
		9. Marine a. Confidence in seagrass-light relationships has not been sufficiently established in determining impacts to seagrass; therefore, more conservative values should be	TropWATER (James Cook University) scientists undertook investigations commissioned specifically for this Project (refer to Volume 3, Appendix M). Their report concluded that a more conservative light requirement value should be applied to nearshore

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5 cont.		used in the interim. Refers to attachment authored by Dr Kathryn McMahon (Edith Cowan University) – seagrass	seagrass communities for impact management during the dredging activities. This advice was incorporated into the adaptive management approach described in the Outline Dredging Management Plan in Volume 3, Appendix W (refer to Section 12.3).
		b. Recovery of seagrass in apron areas within five years is not guaranteed, due to potential removal of seed banks, or the potential of additional natural weather events or the future dredging of the T3 terminal.	As detailed in Section 6.2.11 of the Marine Ecology Technical Report (Volume 3, Appendix Q1), the removal of sediment via dredging of the T0 apron area is unlikely to cause permanent loss of seagrass. The benthic light environment after dredging will not alter significantly from the existing light environment. Sediment characteristics of the resulting seabed immediately after dredging will not be unlike the current seabed sediment characteristics. After a short period (<4 growing seasons) via bioturbation and the deposition of local sediments, the apron area seabed will be similar to the existing seabed and provide no obstacle to the re-establishment of a seagrass community. Transfer of seeds from the regional seagrass community growing in surrounding habitat (and from far field habitat) is likely to occur over successive growing seasons. Based on this assessment the loss of seagrass habitat in the apron area is highly likely to be temporary. A recent study by Rasheed *et al.* (2014) '*Contrasting recovery of shallow and deep water seagrass communities following climate associated losses in tropical north Queensland, Australia*' assessed the recovery of seagrasses at Abbot Point from severe storm impacts. The study found shallow and deepwater seagrass at

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5 cont.			Abbott Point experienced major declines in biomass after a series of cyclones and flood events that occurred during 2011. The study concluded that the deepwater species *Halophila*, prevalent at Abbot Point, had a high capacity for recovery and two years after the impacts from the cyclones had significantly recovered.
		c. The documentation dismisses many reefs closer than Camp Island, which is based on <10% coral cover. However, this is not an appropriate methodology as average coral cover for the Central Section of the GBR based on AIMS surveys is currently only ~14%.	This statement is incorrect. Please refer to discussions in Section 0.
		d. There is insufficient information on habitat utilisation and importance of the area for the marine fauna of Abbot Point, which is based on limited survey data.	Refer to Section 4.1.2.3
		e. The information presented for turtle species' abundance and nesting is largely based on surveys that are brief, short-term surveys and are not adequate sources to base decisions on population sizes, importance, and trends within the project area. Additional management measures such as construction and dredging activities being conducted outside of the turtle nesting season and the dredge to be fitted with a turtle exclusion device (TED) are required	Refer to Section 4.1.2.4

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5 cont.		f. Insufficient assessment of the Dugongs and their utilisation of the seagrass beds in the study area has been provided in the EIS.	Refer to Sections 4.1.2.3 and 4.1.2.5
		g. There is insufficient information regarding the population dynamics, habitat use and movements of marine migratory species, such as the Australian Snubfin and Humpback Dolphins, for this specific area.	Refer to Section 4.1.2.5 and 4.1.2.4
		10. Offsets - The proposed offsets for impacts on the marine environment from the dredging project are not consistent with the EPBC Act environmental offsets policy, and fall further short of the international standards set by the Business and Biodiversity Offset.	The offset proposal has been further developed as discussed in Section 5.2
		11. The Cumulative Impact Assessment is not considered adequate, and cumulative impacts should be reassessed to include the future T3 dredging operations as well as considering the existing T1 operations as an impact rather than part of the baseline. Cumulative impacts also need to be extended beyond the project area to consider impacts at a wider scale. Includes an attachment authored by Jon Day (James Cook University) – which includes discussion on the appropriate scope of cumulative impacts Assessment.	Refer to Section 4.1.2.11

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5 cont.		12. Detailed management plans have not been included in the EIS, and should be submitted for approval and public comment prior to commencement of works.	Refer to Section 4.1.1.6
		13. GBRWHA and National Heritage - the EIS does not present an adequate assessment of the Project on the Outstanding Universal Values associated with the GBRWHA, and fails to address the significance of several attributes of the site as World Heritage values, or properly consider all possible impacts, including cumulative impacts, upon them. The submission includes an attachment authored by Jon Day (James Cook University) – which provides a view on the appropriate interpretation and consideration of OUV in relation to the GBRWHA and World Heritage values.	The draft EIS for the Project assessed all potential environmental values at Abbot Point and whether they are present in a manner that contributes to the OUV of the World Heritage Property. The assessment has been conducted by qualified specialists in their respective fields and the Queensland Government has considered how best to accommodate port development now and into the future, while also achieving a net benefit for the GBRWHA. This is reflected in the offset strategy (refer to Section 5.2). The assessment of impacts of the Project on the OUVs associated with the GBRWHA has taken into account all potential risks and residual impacts associated with the Project on those OUVs of the GBRWHA expressed at the Port of Abbot Point. The Project is consistent with the recommendations of the *Reef 2050 Long-Term Sustainability Plan* where the proposed short-term dredging action is confined to a Priority Port Development Area and beneficial reuse of dredged material is planned. All potential risks on the values of the GBRWHA associated with the Project have been addressed. As concluded in Section 4.6.5 of the draft EIS (Volume 2), the impacts from the Project on the values of the GBRWHA and National Heritage Place are localised and are mostly temporary in nature, and with the proposal to achieve a net benefit for water quality and

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5 cont.			seagrass in the region, overall it is considered highly unlikely for there to be a loss of OUV or decline in the integrity of the GBRWHA as a result of the Project. The assessment of cumulative impacts includes an assessment of cumulative impacts on OUVs expressed at Abbot Point (Section 6.3.4 of the draft EIS). This is now a matter for consideration by the Minister.
		14. The GBRMP – The EIS does not present an adequate assessment of impacts on the Park.	Section 4.7 of the draft EIS (Volume 2) outlines potential impacts on the GBRMP. The Section includes a comprehensive risk assessment, and an assessment of potential project impacts to the Park's values have been based on the *Significant Impact Guidelines 1.1* (DoE, 2013). This includes consideration of impacts from sediment and runoff, noise and physical impacts to threatened/migratory species, and impacts to supporting terrestrial habitat that may be modified. Consequential and cumulative impacts on the Park are also discussed in Section 6 (Volume 2) of the draft EIS.
		15. Direct and indirect impacts of the Project on migratory shorebirds and threatened species have been underestimated, for example:	
		a. Sediment plume from dredging and discharge pipe, and resuspension of sediments.	Refer to Section 4.1.2.1
		b. Impacts to turtle and dugong populations due to loss or degradation of seagrass habitat and direct vessel	Refer to Section 4.1.2.5 and 4.1.2.8

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5 cont.		strikes.	Refer to Section 4.1.2.3
		c. Decline in water quality of the wetland through stormwater release and DMCP leakage.	Refer to Section 4.1.1.3
		d. Noise disturbance to shorebirds.	Refer to Section 4.1.2.8
		e. Inadequate sampling of ASS and therefore underestimation and mismanagement of its impact.	Refer to Section 4.1.1.4
		16. Inadequate information to enable the Minister for the Environment to make a properly informed decision on the EIS.	The draft EIS, Volume 2, has been prepared in response to DoE's EIS Guidelines for the Project (Volume 3, Appendix A). The draft EIS has been structured and developed to reflect the requirements of these guidelines in order to enable the Minister to make a decision regarding the Project.
6	Department of Transport and Main Roads (Queensland Maritime Safety) *State Government*	1. Need to ensure that the potential generation of the ship-sourced wastes (pollutants) by any of the vessels (particularly during the construction phase of the Project) have been considered.	Detailed mitigation measures will be included in final management plans anticipated to be conditioned in the Project Approval.
		2. Consideration must also be given to the fleet of construction vessels and their individual and collective requirements, especially in regard to onshore disposal options (e.g. sewage pump-out, garbage bins, oily bilge water collection, etc.).	Detailed mitigation measures will be included in final management plans anticipated to be conditioned in the Project Approval.

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6 cont.		3. Navigational arrangements such as the likely operating limits (with respect to wind strength and sea state) and Cyclone Contingency Plans for all vessels need to be explicitly stated. Furthermore, there should be a commitment to: a. Fund any and all operating and maintenance expenses associated with Aids to Navigation installation, removal, relocation required for the construction and operational phases of the Project. b. Fund any and all operating and maintenance expenses associated with Vessel Traffic Management services required for the construction and operational phases of the Project. c. Engage with MSQ to agree on appropriate Proponent funding for ship-sourced pollution prevention mitigation strategies and ship-sourced pollution response training. d. Engage with MSQ to agree on appropriate Proponent funding for the provision of expert maritime and nautical advice.	The operating limits for floating plant used for the capital dredging program will be dependent on plant size and type nominated by the contractor selected to undertake the dredging. A medium to large self-propelled CSD will be required due to the offshore dredging location and large pumping distances. These size CSDs can operate in exposed conditions with their operating limits typically ranging up to 0.8m and 1.4m swells for medium and large CSDs, respectively. Whilst the CSD will be equipped with its own storm anchor, during significant storm events, it will demobilise from the dredging location and moor at a safe location out of the storm range, such as Townsville or Mackay. Cyclone moorings will also be required for dredge plant support vessels if they are unable to utilise existing cyclone moorings at nearby Port Denison (Bowen). Emergency Response and Cyclone Contingency Plans will be developed prior to the dredging commencing in consultation with MSQ once a dredging contractor has been selected to undertake the dredging. Final navigational arrangements will be addressed and agreed with MSQ once a dredging contractor is engaged and prior to the commencement of construction.

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6 cont.		4. The EIS should detail the consequences of ship grounding and any mitigation measures required.	Increased shipping directly associated with the Project is expected to be minimal. However, it is acknowledged that the associated T0 project will result in increased shipping. As such, Section 6.3.3.6 of the draft EIS (Volume 2) on consequential and cumulative impacts assesses a number of impacts associated with increased shipping – including a separate section on 'ship groundings and collisions'. The section also provides details from the findings of a number of specific shipping studies that have been conducted in the Abbot Point area over the year. Refer to Section 4.1.2.12
		5. The EIS should consider the issue of strikes on marine species and identify control measures available, for example speed restrictions.	The draft EIS assessed that the Project posed a low risk of vessel strike to marine species. Management measures are included in the Outline Dredging Management Plan (refer Section 4.1.2.5). The risk of vessel strike associated with increased shipping from related projects was discussed in Section 6.3.3.6 of the draft EIS (Volume 2). Refer to Section 4.1.2.12
		6. Statement made in Table 6-1 in EIS related to potential spill risk associated with increased shipping activity not being significant is not accurate and should be reviewed.	Refer to Section 4.1.2.12
7	Matt and Karen	1. Commercial and recreational fishers will be negatively	Refer to Section 4.1.2.13

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7 cont.	Quadrell Reef Ecologic Pty Ltd *Commercial fishers and environmental advisor*	impacted by this and related projects due to cumulative declines in water quality, habitat and increase in sediment, noise, light, vessel movement, vessel anchoring and potentially incidents. To date there has not been a collaborative relationship between proponents and other stakeholders. The Queensland Government/NQBP need to change their attitude and work positively with fishers, and recognise the impacts and compensate fishers financially and though habitat enhancement.	
		2. Seagrasses are important for fish, habitat and fisheries, and impacts must be adequately offset. There are different estimates of impact and offsets required between the EIS ($351,923) and Reef Ecologic ($11.85M over 5 years). The methodology, negotiation, outcomes and funding for seagrass offsets and offsets more generally need to be discussed and agreed by stakeholders and independent experts.	Refer to Sections 4.1.2.3 and 5.2
		3. Corals are important for fish and fish habitats, and impacts must be avoided or offset. Reef Ecologic estimates are approximately $3.3M to $6.07M over 5 years. The methodology, negotiation, outcomes and funding for coral offsets and offsets more generally need to be discussed and agreed by stakeholders and independent experts.	No coral reefs will be impacted by the Project.

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7 cont.		4. Climate change is one of the biggest threats to the GBR and this Project has a significant global greenhouse gas emission of 232,716,297t CO2-e over 60 years. The greenhouse gas impact needs to be offset to 'neutral' so that there is no global impact and threats to the GBR and its stakeholders.	Refer to Section 4.1.2.10
8	Alliance to Save Hinchinbrook *Community / conservation group*	1. The Project will harm threatened species and thousands of migrating birds that use the nationally listed Caley Valley Wetlands.	Refer to Sections 0 and 4.1.2.8 As summarised in Section 4.4.9 of the draft EIS, assessment of the impacts of the Project on waterbirds and migratory shorebirds that utilise habitats within the Caley Valley Wetlands has been undertaken for all identified risks associated with the construction and operation of the DMCP. A project buffer area of land between 50m and greater than 300m will be established between the project site and the Caley Valley Wetlands. This will buffer the wetland from direct impacts associated with the DMCP. Indirect impacts from surface water, groundwater, dust and noise have been modelled and the potential risks to the Caley Valley Wetlands and associated fauna have been assessed as low, with no net residual impact.
		2. The Project will hasten the onset of climate change, the greatest threat to all life on the planet including human life, because the purpose of the port expansion is to increase the mining and export of coal.	Refer to Section 4.1.2.10
		3. Climate change, bringing rising sea temperatures and ocean	Refer to Section 4.1.2.10

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8 cont.		acidification, will push significant parts of the life of the GBRWHA to rapid extinction.	
		4. Dredging of the seabed would destroy seagrass meadows. Already, GBRWHA-wide, seagrass has disappeared from many sites where it was once common and healthy.	Refer to Section 4.1.2.3
		5. The act of dredging creates long-lasting plumes of sediment, carried long distances by currents, which will affect corals, including corals close to the dredging area.	Refer to Section 4.1.2.1
		6. The increased shipping is a further serious risk to the GBRWHA, including impacts caused by anchoring, the trapping and drowning of marine mammals underneath ships, pollution from shipping.	Refer to Section 4.1.2.12
9	Whitsunday Regional Council *Local government*	1. Ensure that the projects currently undertaken by Council in conjunction with the North Queensland Dry Tropics, continue to occur to manage the impacts of pests and weeds on the Caley Valley Wetlands. Furthermore, Council would also appreciate the coordination of these projects with the Abbot Point Growth Gateway Project.	The DSD is committed to working with Council to coordinate activities in the Abbot Point area as appropriate. It is confirmed that the Project will not interfere with existing projects planned to be undertaken in the Caley Valley Wetlands.
		2. Ensure any hydrological influences that emanate from the Project are managed onsite and do not affect the Caley Valley Wetlands.	Refer to Section 4.1.1.3

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9 cont.		3. A management plan should be implemented to ensure that environmental impacts are minimised in the event of inundation. In particular, storm surge or flood should not be the cause of the release of contaminants into the wetland area or ocean.	Refer to Section 4.1.1.3
		4. Ensure the implementation of an emergency management plan for particular events, such as: spills, pollution, extraction throughput (i.e. ponds, dredging etc.), instance of disaster and the like. The management plan should address all applicable emergency events and measures to minimise impact on any area of national environmental significance.	Refer to Section 4.1.1.3
10	Abbot Point Bulkcoal (APB) (Glencore) *Industry stakeholder*	1. The existing NQBP monitoring bores are used by APB to monitor groundwater. These bores are acknowledged in the draft EIS. However, the water quality appears not to have been documented, especially in regard to Electrical Conductivity. Based on the salinity classification definitions, bore 4's water quality classification would range from freshwater to brackish whilst the bore 5 water quality would be classified as fresh water only.	Two monitoring bores (MW04 and Site 6) indicate the presence of freshwater, which is classified in the Groundwater Assessment report as water having a salinity level less than 500mg/L (or less than ~750µS/cm). Freshwater was only observed from the salinity profiling in the monitoring bores. The water quality in these bores then becomes brackish with depth, which in keeping with the general trend observed across the site. That is, the monitoring bores intersect brackish to saline groundwater overlying hypersaline groundwater. This stratification was discussed in Section 4.6.1 of the Groundwater Assessment Report (Appendix L of Volume 3). It is noted that Figure 4.5 of the report has incorrectly plotted the lower limit for brackish water as 1.5mS/cm (1,500µS/cm), when this

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10 cont.			should be 0.75mS/cm (750µS/cm). However, none of the NQBP bores would be classified as fresh water, rather they would be classified as brackish to saline.
		2. APB would like to have further information on the mitigation measures or risk treatments that are being taken to prevent potential environmental impacts on groundwater that is classified as fresh that is located in the vicinity of the proposed dredge ponds.	As stated, freshwater was only measured at two locations (MW04 and Site 6) from the salinity profiling within the NQBP and draft EIS monitoring bores. However, the general trend with regard to groundwater quality for salinity in the vicinity of the proposed DMCP, indicates a brackish to saline groundwater overlying a hypersaline groundwater. Vegetation communities discussed in Section 4.1.3.7 'Groundwater Dependant Ecosystems' of Volume 3 Appendix O occur on the sand dunes in the east of the study area adjacent to the ocean which would not be directly influenced by the 'freshwater' groundwater detected at MW04 and Site 6. To date, the only known monitoring data for the eastern dune comes from the NQBP monitoring bore GW06, which detected brackish conditions. As the vegetation communities are not salt tolerant species, it was concluded that these communities were not dependent on groundwater flows, but are likely influenced, and dependant on, freshwater overland flow. On this basis environmental impacts are not anticipated.
		3. APB would also like information on how the existing NQBP monitoring bores will be maintained or relocated to enable APB to continue to monitor the groundwater under and immediately adjacent to T1, as per APB's Environmental	DSD is committed to continuing consultation with key stakeholders, including APB, as the project continues to address adverse impacts to existing infrastructure such as groundwater monitoring bores used by APB for environmental management and compliance

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10 cont.		Management Plan.	purposes. Further work will be progressed with existing and, where appropriate, future port users to ensure that the Abbot Point Growth Gateway Project's environmental management plans and their associated monitoring programs are designed to be delivered in a sustainable manner. New environmental monitoring associated with the Project will consider impacts to existing APB monitoring programs and how these impacts could be mitigated (such as through relocation of bores prior to commencement of works). In addition, where possible, environmental monitoring will be designed to allow impacts from respective developments to be understood so that adaptive measures can be implemented.
11	NQBP *Industry stakeholder*	Manifesting support for the Project.	Comments noted.
12	Australian Coral Reef Society *Community / conservation group*	1. CSD unsuitable for open ocean work.	The operating limits for floating plant used for the capital dredging program will be dependent on plant size and type nominated by the contractor selected to undertake the dredging. A medium to large self-propelled CSD will be required due to the offshore dredging location and large pumping distances. These size CSDs can operate in exposed conditions with their operating limits typically ranging up to 0.8m and 1.4m swells for

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12 cont.			medium and large CSDs, respectively. Analysis of historic wave records and discussions with dredging contractors indicate limited downtime for larger CSDs is expected due to adverse sea conditions, with slightly more downtime expected for medium CSDs.
		2. EIS sediment disturbance and plumes seem underestimated.	Refer to Section 4.1.2.1
		3. Coral reefs exist close to the dredging area and will be impacted.	Refer to Section 4.1.2.2
		4. EIS states no coral reefs exist close to the dredging area but the marine technical report excludes reefs with coral cover up to 10%, which is significant.	Refer to Section 4.1.2.2
		5. Timing of dredging is not considered around any biological events such as coral spawning, fish spawning or turtle nesting.	Refer to Section 4.1.1.5
		6. Effects of coal dust are not considered, especially considering the Burns *et al*. study (2014), which found that levels of Polycyclic Aromatic Hydrocarbons exceed guideline levels.	The Project will not result in any direct emission of coal dust. However, it is acknowledged that the impacts of the associated T0 project will include impacts related to coal dust emissions. These impacts are noted in the Air Quality Technical Assessment (Volume 3, Appendix Q - Section 6.2) and assessed in detail in the T0 EIS (CDM Smith, 2013a).

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12 cont.		7. There is no discussion on effects of cyclones and floods on the DMCP.	Refer to Section 4.1.1.3 and Section 4.3.6.3 of the draft EIS
		8. Water seeping from the DMCP will flow through the estuary bordering Curlewis Bay, adding to the erosion rate of the existing mudflats that are the feeding ground for EPBC-listed migratory shorebirds.	Refer to Section 4.1.1.3 and 4.1.2.8
		9. The acidification hazard of the PASS is high where the bund walls will be located.	Refer to Section 4.1.1.4
		10. No scientific data to support the claim that hypersaline groundwater is likely to hinder acid formation and buffer acid flushes from Actual Acid Sulfate Soils (AASS).	It is noted that there is no AASS in the DMCP location. Please refer to the technical memorandum attached at Appendix D for confirmation of the self-neutralising capabilities of the PASS dredged material.
		11. Insufficient information is provided to demonstrate that any acidic groundwater will be successfully managed by proposed solutions.	Refer to Section 4.1.1.4 and 4.1.2.4
		12. Long-term data to demonstrate that dredge spoil will be self-neutralising has not been presented.	Refer to Section 4.1.1.4
		13. It is probable that an area of unknown size around the vicinity of Abbot Point will be lost to Dugongs due to loss or	Refer to Section 4.1.2.5 and 4.1.2.3

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12 cont.		degradation of seagrass habitat.	
		14. The cumulative impacts of natural stressors combined with future developments associated with port expansion and onshore activity have the potential to severely impact seagrasses in the region.	All impacts from offshore operations such as anchoring or plumes from propeller wash are limited to areas which are too deep to support seagrass growth. Cumulative and Consequential impacts were addressed in Volume 2, Section 6 of the draft EIS.
		15. Possibility of a chronic sediment plume that persists throughout dredging activities and is maintained to some extent by shipping traffic and altered flow patterns around construction. The extent and longevity of such a sediment plume is unknown.	Refer to Section 4.1.2.1
		16. Degradation of any seagrass beds that do remain in the vicinity post-construction phase is likely to occur during operation of the port.	All impacts from offshore operations such as anchoring or plumes from propeller wash are limited to areas which are too deep to support seagrass growth.
		17. Loss or degradation of seagrass beds may hinder Dugong movements and gene flow in the region. Understanding of how Dugongs cope with this discontinuity of coastal habitat is needed.	Refer to Section 4.1.2.3
		18. Boating traffic may result in increased mortality and injury due to boat strike.	Refer to Section 4.1.2.12
		19. The EIS gives no indication about the timing of the dredging.	Refer to Section 4.1.1.5

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12 cont.		The dredge period should avoid the turtle nesting period.	
		20. Dredging of the seabed to deepen the port will directly remove fish habitat such as boulders and corals.	Detailed bathymetry surveys of the T0 berth pockets and apron areas found no areas of boulders or corals. Underwater video surveys of the berth pocket and apron area have also not found any boulders or corals.
		21. Toxicants in seawater have a range of lethal and sub-lethal effects on fishes (Sprague, 1971), and may increase toxicity of fish flesh for human consumption.	No toxic chemicals will be released in sufficient concentrations (above background) during dredging.
		22. Suspended sediment can negatively affect fish respiration, and larval dispersal through destroying important chemical cues.	The amount of fines released into the marine environment via dredging is minor compared to a single high wind-and-wave episode, which occurs on a regular basis at Abbot Point. Cyclonic conditions are also prevalent at Abbot Point. The extent of the dredging plume (hundreds of meters) and the concentrations of suspended sediment is minor compared to the wider extent of plumes due to these natural events, which extend for hundreds of kilometres. It is thus highly unlikely that suspended sediments will impact on the fisheries values of the area outside the boundaries of impact, which occur month-to-month at Abbot Point in any given year.
		23. Additional shipping movements will increase water-borne sediment and ambient noise levels. The latter are known to disorient reef fish and their larvae.	Refer to Section 4.1.2.12 The port has operated for many decades and co-existed with the fishing industry. The increase in shipping and associated activities is

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12 cont.			unlikely to increase the levels of suspended sediment or noise to levels which will impact reef fish and their larvae. The construction of an additional jetty may help fisheries by providing a structure on which coral and other benthic organisms can grow, which will in turn provide safe habitat for fish larvae and additional food resources for fisheries.
		24. This EIS makes no attempt to estimate the potential area of damage from anchorage of ships close to Abbot Point - this is a huge area and the potential damage from the large anchors to benthic animals is vast.	Refer to Sections 4.1.2.5 and 4.1.2.12
		25. Dredging is not GBRMPA's preference. Other options should have been considered and assessed properly.	Refer to Section 4.1.1.2
		26. DMCP alternatives (salt mine and taking it back to mines) not considered.	Use of the Bowen Salt Works as storage area for the dredged material is not a viable alternative when using a CSD due to the distance separating the salt works from the dredging area. Pumping over this long distance is not feasible. A TSHD would therefore be required to transport the material, which would require additional dredging near the Salt Works to allow for access by the TSHD, and therefore further seabed, flora and fauna disturbance, including mangrove flats. Transporting the dredged material to the coal mines would require temporary stockpiling infrastructure and area at the port that would affect the same if not a greater amount of land than what is

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12 cont.			proposed under the Project. In addition, the aim of the Project is to maintain the dredged material at the port for future beneficial reuse.
		27. Return water will flow into the GBRWHA causing sediment plumes and transfer of potentially toxic materials.	Refer to Section 4.1.2.1
		28. The biggest threat to the GBR is from climate change. If we want to protect the GBR in the long-term, we must do all we can to reduce emissions. Mining the Galilee Basin is not compatible with this need.	Refer to Section 4.1.2.10
13	The Australian Institute *Independent researcher*	1. The Project is based on flawed economic analysis. There is no analysis as to the financial or economic viability of the Abbot Point Growth Gateway Project, or related projects such as the Terminal Zero (T0) project and the various Galilee Basin coal and rail projects. There is no consideration as to whether these projects will actually proceed under current and forecast coal prices.	An assessment of economic or financial viability of the Project is not required under DoE's EIS Guidelines. Advice from NQBP indicates that the existing 50Mtpa capacity of port and coal handling facilities at Abbot Point is fully contracted for coal output from existing Bowen Basin coal mines. As such, any additional coal production intended for the Port of Abbot Point over and above existing forward contracts would trigger the need for augmentation of port capacity.
		2. The model used to make all of estimates is known as an 'input-output' model. A major shortcoming of these models is that they assume an infinite supply of skilled labour, land, water and all other inputs. They assume a project can proceed without taking resources away from any other	Input-output modelling techniques are widely applied in the evaluation of projects subject to the EIS process in Queensland. Like all modelling techniques, input-output approaches have a range of limitations. These limitations are outlined within the economic impact report (Volume 3, Appendix S). The relevance of

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13 cont.		project or industry. This method of modelling is mathematically certain to overstate positive impacts and cannot show a negative impact on any other industry.	these limitations varies with application. The absence of supply constraints are relevant in the context of very large projects being introduced into a highly supply constrained economic environment. The Project is anticipated to have a capital cost of between \$50 million and \$100 million. In an economic context, this represents a small project, with a capital cost similar to the construction of a grade separated road crossing. The Mackay, Isaac and Whitsunday region has significant capability within the engineering construction segment. The region is currently experiencing high levels of capacity underutilisation and rising unemployment and falling labour force participation. Industry capacity being high and labour force capacity currently being underutilised, the risk of overstatement of impacts is very low. Additionally, the purpose of the economic impact assessment is to anticipate the employment impacts of a given project to allow for mitigation measures for any potentially adverse impacts to be formulated.
		3. There is no discussion of the state of coal markets currently, the impact on the viability of the coal industry locally, or of the wider context of coal in an era of climate change policy and emerging competition from other energy sources. This omission is surprising given the extent to which these issues are discussed by economists, policy makers and the media.	Refer to Section 4.1.1.1 The purpose of the economic impact assessment is to identify the likely consequences of the Project on the economic environment. Issues such as the need for the Project are addressed in other sections of the draft EIS. Advice from NQBP is that the current capacity of the Port of Abbot

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13 cont.			Point (~50Mtpa) is fully contracted for outputs from existing Bowen Basin mines. Any development of additional coal mines within the catchment of the Port of Abbot Point will require augmentation of port capacity. Coal exports from Australia, along with global coal consumption, are expected to increase significantly across a range policy scenarios.
14	North Queensland Conservation Council *Community / conservation group*	1. By excluding consequential impacts from the cumulative impact assessment, the EIS has not adequately addressed the impacts of the Project as required under the EPBC Act. Consequential impacts are an important component of cumulative impacts.	Refer to Section 4.1.2.11
		2. The EIS list of consequential impacts is truncated and should extend to opening the Galilee Basin to coal mining, and therefore include the China Stone mine, Alpha Coal mine and Kevin's Corner mine.	Refer to Section 4.1.2.11
		3. Section 527E of the EPBC Act defines what events or circumstances constitute impacts. It is not 'locationally constrained'; when referring to 'other actions'. In contrast, the CIA in the EIS for the Project constricts analysis to 'the region' or 'the vicinity'. The mine/s and the port require a rail line to be constructed extending from one to the other/s. It is necessary to consider the impact of this rail in its entirety.	Refer to Section 4.1.2.11

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14 cont.		4. The Proponent is arguing that, because a number of 'consequential' impacts of other projects have been individually addressed and accepted one by one, they can be excluded from any CIA process for the Project. This exclusion ignores the fundamental raison d'etre of a CIA, which is designed to avoid 'death by a thousand cuts'.	Refer to Section 4.1.2.11
		5. The EIS does not propose any means of avoiding, mitigating or offsetting the GHG emissions from the related mine, rail and port projects.	Refer to Section 4.1.2.10 The Abbot Point Growth Gateway Project is a separate project, though associated, to the Carmichael Coal and Rail, NGBR and Abbot Point T0 projects. As such, the Proponent does not have a responsibility to mitigate the GHG emissions or impacts of the associated projects. However, the draft EIS (Volume 2) does consider the potential for cumulative and consequential impacts in detail. Specifically, Section 7.2 of the draft EIS considers the GHG emissions that are likely to be produced from the associated projects.
15	Juru *Traditional Owner*	1. Cultural Heritage sites located within and near the proposed impact area are not mentioned in Section 1.3.4. This includes the major Aboriginal Cultural Heritage Area at the eastern dune system that contains major midden sites, deflated and non-deflated camp fire sites and traditional burials. Under the Queensland *Aboriginal Cultural Heritage Act 2003*, the area of the Eastern Dune System has to be classified as a	Section 1.3.4 of the draft EIS refers to Aboriginal cultural heritage sites that have been registered on the Aboriginal Cultural Heritage Database and Register, administered by the Queensland Department of Aboriginal and Torres Strait Islander Partnerships under the *Aboriginal Cultural Heritage Act 2003*. Not all Aboriginal cultural heritage sites in Queensland are registered.

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15 cont.		'Significant Aboriginal Area'. The area requires a minimum 50m buffer zone to protect it from any damage.	The registration of the areas mentioned as a 'Significant Aboriginal Area' is not a matter for this Project. This is a matter for the Queensland Department of Aboriginal and Torres Strait Islander Partnerships and the administration of the *Aboriginal Cultural Heritage Act 2003*.
		2. The current Cultural Heritage Management Plan (CHMP) between Juru Enterprises Limited (JEL), NQBP and the Coordinator General has not been efficient thus far in the identification of and preservation of the Eastern Dune System (Abbot Point Beach), Dingo Beach and Shark Bay. The current measures do not protect these areas enough as they are currently not registered as Significant Aboriginal Areas as they should be, and minimum buffer zones of 50m need to be enforced to maximise protection.	Potential impacts on Aboriginal cultural heritage in undertaking the Project have been managed under the cultural heritage management procedures in the Port of Abbot Point and Abbot Point State Development Area Indigenous Land Use Agreement QI2011/063 (Abbot Point ILUA). The parties to the Abbot Point ILUA are the Juru People Native Title claimants, JEL (as the Juru Nominated Body), the State of Queensland, NQBP and the Coordinator-General. Compliance with the cultural heritage management procedures in the Abbot Point ILUA satisfies the cultural heritage duty of care under the *Aboriginal Cultural Heritage Act 2003*.
		3. The dredge and return pipe alternative option crosses the dune system on the southern side of the Material Offload Facility (MOF) and this area contains middens and may also contain burials.	Aboriginal cultural heritage surveys have been undertaken within the project area and mitigation measures to avoid or minimise harm to Aboriginal cultural heritage in the undertaking of the Project have been agreed with the Juru People, in accordance with the cultural heritage management procedures in the Abbot Point ILUA.
		4. What Juru People have undertaken surveys and mitigation and management strategies as stated in the EIS? My family	Aboriginal cultural heritage surveys have been undertaken within the project area under the terms of the cultural heritage

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15 cont.		have not been involved and I know that the other families do not have the intimate knowledge of the area.	management procedures in the Abbot Point ILUA. The administration of the Juru People's responsibilities under the Abbot Point ILUA is a matter for the Juru People.
		5. No consultation with my family.	Compliance with the cultural heritage management procedures in the Abbot Point ILUA satisfies the cultural heritage duty of care under the *Aboriginal Cultural Heritage Act 2003*.
		6. No due diligence done by DSD in respect to making sure that the Juru People they have dealt with have had appropriate knowledge of the area.	The Aboriginal cultural heritage surveys and development of mitigation measures were undertaken in accordance with the cultural heritage management procedures in the Abbot Point ILUA. The administration of the Juru People's responsibilities under the Abbot Point ILUA is a matter for the Juru People.
		7. In application of Section 58(a) of the *Native Title Act 1993*, due to Kyburra only holding Juru people's Native Title in trust, Kyburra cannot act as agent or representative of the Juru common law holders and cannot enter into agreements binding them. Therefore any agreements with Kyburra that are binding on the Juru common law holders are null and void.	The Queensland DSD entered into an agreement with Kyburra Munda Yalga Aboriginal Corporation (Kyburra) in relation to the management of cultural heritage for initial geotechnical site investigations for the Project. Kyburra, as the registered Native Title body corporate for the Juru Native Title determination at Abbot Point (QUD554/2010), is the appropriate party to enter into such an agreement under the *Aboriginal Cultural Heritage Act 2003*, as the project area is within the external boundaries of the Juru Native Title determination. All other aspects of Aboriginal cultural heritage for the Project have been managed under the cultural heritage procedures in the Abbot Point ILUA. The Juru People Native Title claimants are the party to

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15 cont.			this ILUA.
		8. The objectives of the EPBC Act around the involvement of Indigenous people (last two) have not been implemented under the EIS, as studies did not involve local Juru people despite their intimate knowledge of the area.	The draft EIS studies were undertaken by professional specialists. It is acknowledged that these studies did not involve specific consultation with the Juru People. The Aboriginal cultural heritage surveys took account of potential impacts of the Project on marine fauna and other wildlife habitat.
		9. The following areas within the Abbot Point SDA require registration as Significant Aboriginal Areas under the Aboriginal Cultural Heritage Act: Dingo Beach, Shark Bay, Around Mount Roundback, Caley Valley Wetlands and Saltwater Creek.	The registration of these areas as a 'Significant Aboriginal Area' is not a matter for consideration as part of this Project. This is a matter for the Queensland Department of Aboriginal and Torres Strait Islander Partnerships and the administration of the *Aboriginal Cultural Heritage Act 2003*.
		10. The assessment of environmental outcomes should be conducted outside of the Queensland Government departments to prevent bias.	Refer to Section 4.1.3.2
		11. Did not find any mitigation measures for the increased salinity of underground water through the leaching of salt through the floors of the sediment ponds.	Refer to Sections 4.1.2.6 and 4.1.2.4
		12. This leaching of salt into the underground water tables will increase the salinity of the underground water and as such will leach through into the Caley Valley Wetlands.	Refer to Sections 4.1.2.6 and 4.1.2.4 Section 4.3.4 of the draft EIS (Volume 2) and the detailed Groundwater Technical Assessment (Volume 3, Appendix L) discuss the transport of salinity into groundwater. Impacts to the

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15 cont.			groundwater regime are assessed as a low risk. The interaction between groundwater and the Caley Valley Wetlands has been considered. The hydrology assessment (Volume 3, Appendix O) modelled scenarios, which incorporated regional groundwater estimations (including salinity) derived from the groundwater modelling. The results of the hydrology modelling predict that the Project results only in minor changes to salinity, which are within the range of natural variability of the wetland.
		13. Increased salinity of the wetland will kill off the fresh water turtles. The turtles leave the wetland to breed and hibernate late in the year before the wet seasons due to the increased salinity that occurs naturally. If the salinity is artificially increased through leaching of salt into the underground water, the turtles will leave the wetland earlier than normal and as such will dehydrate and die due to longer periods out of the wetland. A similar risk is anticipated for freshwater crabs that inhabit the wetland.	Refer to Section 4.1.2.5 and 4.1.2.6 While no species of freshwater turtle present at Abbot Point is listed as threatened under the EPBC Act, a general assessment of the potential impacts of the Project on water quality and habitats within the Caley Valley Wetlands was undertaken. Section 4.3.6.3 of the draft EIS provides the results of the assessment that takes into account the groundwater modelling results for the Project. The modelling showed that under worst-case conditions, the greatest change to salinity would be experienced immediately adjacent to the DMCP where salinity may increase by up to 3ppt above background conditions. This increase is small when compared to the natural (seasonal) variations of salinity experienced in the wetland. The assessment concludes that the results of the realistic and worst-case wetland hydrology scenarios indicate that persistent detrimental impact on aquatic flora and fauna within the 'wetted' sections is not expected to occur due to operation of the DCMP,

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15 cont.			and that any impacts to aquatic communities are expected to be short-term, with rapid recovery occurring in the next wet season following the completion of works.
		14. Freshwater turtles and crabs inhabiting the wetland are not accounted for in the EIS.	Refer to response outlined in part 15.13 of this table.
16	Department of Agriculture and Fisheries *State Government*	1. How long will the return water pipeline remain in place after the dredging has been completed?	It is expected that the dredging contractor will take between six and eight weeks to demobilise the plant and equipment from site, including pipework, following the completion of dredging.
		2. Extending the jetty 2.3km further out to sea would mean no dredging required as per Option 2 on page 66. This would mean no impacts on seagrass or fisheries habitats. Further investigation of this option should be provided.	Refer to Section 4.1.1.2
		3. It is unclear if there will be a return to the pre-disturbance conditions in the dredging area given the depth and sediment changes. Provide further evidence that seagrass will recover to pre-disturbance levels within five years of dredging. Should this not be the case, offsets would be required.	Refer to Section 4.1.2.3 and Section 6.2.11 of the Marine Ecology Report (Volume 3, Appendix Q1)
		4. Seagrass removal from dredging should be offset under the *Environmental Offsets Act 2014*. If the argument is being	Refer to Section 4.1.2.3

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16 Cont.		made that the impact has been assessed under a Commonwealth Act for the same impact on the same matter, it should be made very clearly. Guidance from the Department of Environment and Heritage Protection on this matter would be beneficial.	
		5. Need to engage with commercial fisheries to determine compensation. Use of Department of Agriculture and Fisheries guideline on compensation may assist.	The Proponent carried out a proactive consultation program with a range of stakeholders, including commercial fishers, as described in Section 1.6 of the draft EIS and in Section 2 of this report. Volume 3, Appendix T of the draft EIS assessed in detail potential impacts to commercial and charter fishing operations, and recreational fishing activities. This assessment was based on available logbook data and took into account logbook reporting grid arrangements in and around the Port of Abbot Point. This assessment found that the impacts from the proposed dredging activity and related temporary underwater pipeline infrastructure on fisheries would be negligible and would not impact fisheries production and catch in any significant way. The Fisheries Technical Report concluded that port activities and commercial and recreational fishing at Abbot Point have co-existed and would continue to co-exist. In addition to the short-term temporary impacts of the proposed dredging activity and related temporary underwater pipeline infrastructure on fisheries, the draft EIS considered the impacts of increased shipping movements and anchorages. These particular

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16 cont.			impacts, which are related to the broader port expansion are being addressed separately via the North East Water Space Management Working Group.
17	Greenpeace *Community / conservation group*	1. There is no time limit proposed for dredging or the construction of the DMCP. There is no recognition that the impacts on the marine ecosystem will vary depending on the time of year that the dredge campaign is undertaken.	Refer to Section 4.1.1.5
		2. There are coral reefs present in the area but they have been ignored and the potential impacts from increased turbidity left unassessed.	Refer to Section 04.1.2.34.1.2.2
		3. Given the uncertainty of the impacts, the potential for sediment plumes to cause long-term, lasting damage to the Reef and the risks associated with onshore disposal, this Project should not proceed.	Refer to Section 4.1.2.1
		4. The information presented for Dugongs, dolphins, the Giant Manta Ray and turtle species is based on a limited number of surveys and is insufficient to make sound decisions that there will be no impact on these species.	Refer to Section 4.1.2.5 and 4.1.2.3
		5. The risk assessment does not provide sufficient evidence of	The engineering design of the DMCP has provided freeboard for

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17 cont.		why a 'low consequence' category was given to *"failure to contain-overtopping"* or *"failure to contain-seepage"* given the proximity of the DMCP to the GBR and the Caley Valley Wetlands.	extreme storm and wind/wave action above the maximum operating water level in the DMCP. Dredged material supernatant water is essentially seawater with suspended sediment which would be diluted with rain water above the Maximum Operating Level, such that the small contaminant load of any water that were to overtop the DMCP would be of low consequence to the wetland. Overtopping water does not have a direct pathway to reach the GBR. The engineering design of the DMCP has provided measures including constructing the embankment with specified compaction of suitable earthfill, incorporation of an internal wall geosynthetic liner to minimise seepage and concurrent measures to extend the flow path length of seepage that does occur. Dredged material supernatant water is essentially seawater with suspended sediment, such that water that seeps from the DMCP would be of small quantity with low consequence to the Caley Valley Wetlands. The Engineering Risk Analysis of dredged material containment has been provided as Appendix E.
		6. Elevated heavy metals and TBT identified in the material to be dredged in previous proposal assessments have not been included in the current one.	The comment makes reference to a review of previous sediment quality assessments included within discussion in Section 3.4.1.3 included in the PER (GHD,2012). While the discussion in the PER notes that several previous programs have identified the occurrence of was TBT, in individual

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17 cont.			samples at levels greater than guideline values, it further outlines analysis across samples identifies a mean concentration less than the former National Ocean Disposal Guidelines for Dredged Material (Environment Australia, 2002) and National Assessment Guidelines for Dredging screening levels. The elevated TBT found in isolated sediment samples are likely to be from individual paint flakes from ship hulls. The use of TBT in antifouling paints is now banned to limit the amount of TBT entering the marine environment. Higher concentrations of TBT are more likely to occur in the existing berth pockets rather than in undisturbed seabed sediments. The results of the sediment characterisation study (as part of the T0, T2 and T3 Capital dredging Project) into the sediments to be dredged in the T0 dredging area (berth pockets and apron areas) found no samples of sediment contained concentrations of TBT above the Laboratory Level of Reporting (non-detect) and therefore no TBT concentrations above the applicable guidelines. Additionally, it is noted that TBT relates primarily to its presence in the marine environment. Should TBT (e.g. paint flecks) be present in the dredged material stored within the DMCP, this poses a much lower concern as it will not be bioavailable.
		7. Insufficient mitigation measures commensurate to risks are provided for potential impacts to the Squatter Pigeon and Australian Painted Snipe.	The draft EIS has assessed the risk to Squatter Pigeon and Australian Painted Snipe. The outline EMP includes appropriate mitigation measures taking into account the results of the impact

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17 cont.			assessment. Refer to Section 4.1.2.8
		8. Contaminants that could be contained in the stormwater from DMCP is unknown.	As stated in the draft EIS (Volume 2, Section 2.2.2.3) sediment screening found that sediment did not contain contaminants at levels of environmental concern.
		9. The Stormwater Management Plan is only very preliminary and does not deal with heavy wet season rains, storms or cyclone impacts.	Refer to Section 4.1.1.6 Following the completion of dredging, the dredged material will be landformed and revegetated where necessary to minimise erosion from rainfall and storm runoff within the ponds. The embankments may be removed or notched to suit the final Stormwater Management Plan, such that the internal landforming will generate flows to the receiving environment that generally mimic the underlying natural preconstruction drainage pathways. Sediment control pond areas will be incorporated into the landform design to provide rainfall detention for sediment control purposes. Armoured sill and chutes will be incorporated into the sediment pond outlets to assist in erosion stability. Further detail on stormwater management is provided in the draft EIS Volume 3, Appendix Y – Section In light of the above, the Proponent considers that the preliminary Stormwater Management Plan is sufficient for the purpose of the draft EIS. A final Stormwater Management Plan will be developed prior to the commencement of construction.

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17 cont.		10. An expansion of shipping numbers should not be permitted in light of the past recent oil spill, whale strike and grounding.	Refer to Section 4.1.2.12 Note that between July 2014 and June 2015 there were 324 ships loaded at the Port of Abbot Point. The comment states that there are currently 147 ship visits per year, which is based on outdated information.
18	University of New South Wales – Centre for Ecosystem Science *Independent researcher*	1. There is little information on how stormwater will be managed, how impacts will be measured and how ultimately practices may be changed if there are severe environmental impacts.	Refer to Section 4.1.1.6 Following the completion of dredging, the dredged material will be landformed and revegetated where necessary to minimise erosion from rainfall and storm runoff within the ponds. The embankments may be removed or notched to suit the final Stormwater Management Plan, such that the internal landforming will generate flows to the receiving environment that generally mimic the underlying natural preconstruction drainage pathways. Sediment control pond areas will be incorporated into the landform design to provide rainfall detention for sediment control purposes. Armoured sill and chutes will be incorporated into the sediment pond outlets to assist in erosion stability. Further detail on stormwater management is provided in the draft EIS Volume 3, Appendix Y – Section In light of the above, the Proponent considers that the preliminary Stormwater Management Plan is sufficient for the purpose of the draft EIS. A final Stormwater Management Plan will be developed prior to the commencement of construction.

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18 cont.		2. There is relatively little information on potential mobilisation or exchange of acidity and heavy metals with the wetland, although this can occur through the stormwater input, leakage and interactions through the groundwater under the site.	Available information (refer to Volume 2, Appendix L, Section 7.3) indicates that sediments will not leach significant quantities of metals/metalloids. A groundwater monitoring program is proposed to be developed and implemented.
		3. There is inadequate information or a framework for monitoring potential impacts on the wetland from airborne pollutants (dust).	The draft EIS (Volume 2, Section 4.3.2 and Volume 3, Appendix H) assesses air quality impacts. Dust level predictions have been considered within the ecological assessment (Volume 2, Sections 4.3.7 and 4.5). The final EMP for the Project will be developed incorporating appropriate measures to mitigate and monitor potential dust impacts.
		4. There are inadequate data to determine the full spatial and temporal habitat use of different species, essential to a comprehensive assessment of impact.	Refer to Section 0
		5. There is inadequate consideration of the cumulative impacts of this Project and several other coastal developments along the east coast of Australia, which is a major migratory network for shorebirds.	Refer to Section 4.1.2.11
		6. Information on the migratory network of the key shorebird species that inhabit the wetland, and in particular the critically endangered Eastern Curlew and Curlew Sandpiper, should	Refer to Section 4.1.2.8 and 4.1.2.11

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18 cont.		be considered in the cumulative impact assessment.	
		7. The Project should be compliant with the Commonwealth Government's *Draft Wildlife Conservation Plan for Migratory Shorebirds (2014)*.	The significance of the Caley Valley Wetlands for migratory shorebirds has been established on the basis of the criteria set out in the draft Conservation Plan. The assessment of impacts of the Project on migratory shorebirds addresses the moderate and major threats set out in the Migratory Shorebird Population Risk Matrix of the draft Conservation Plan. There is no proposed wetland habitat loss or removal as a result of the Project and anthropogenic disturbance will be confined to the short–term construction period. Impact mitigation measures are proposed to reduce the impacts of this disturbance so that effects on migratory shorebirds, should they be present during the construction period, are minor.
		8. The submission recommended that a suitable drainage network around the development and build a storage onsite which diverts leakage and stormwater, allowing for the capture of potential pollutants and regular testing for pollutants. Discharge of this water could then occur at a time when it is least likely to impact on shorebird populations.	Refer to Section 4.1.2.8 An appropriately developed Stormwater Management Plan, aligned with the preliminary Stormwater Management Plan provided in Volume 3 (Appendix Y) is considered to be suitable to mitigate impacts of any potential stormwater pollutants on shorebird populations.
		9. The submission recommended that the timing of construction works should occur when migratory shorebirds are predominantly in the northern hemisphere (i.e. May to August).	Refer to Section 4.1.1.5

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18 cont.		10. The Queensland Government must implement best practice rehabilitation works when removing the western bund and causeway to improve flushing of the wetland.	The Project does not involve any works related to, in the vicinity of, or that have any impact on, the western bund and causeway. Therefore, no rehabilitation works are planned in this part of the Caley Valley Wetlands.
		11. It is vital that rigorous data is collected on shorebird populations, wetland function, water quality and also potential pollutants (i.e. heavy metals, acidity), for a significant period (around one to two years) prior to, during and after construction works. A long-term environmental monitoring project should also be initiated, with data made publically available.	Refer to Section 4.1.2.4
19	Australian Heritage Council *Australian Government*	1. Strongly objects to the proposed dredging in the GBRWHA. Has concerns about the disposal of dredged material adjacent to the GBR, since the extent and duration of this impact are not well understood.	The draft EIS for the Project assessed all potential environmental values at Abbot Point and whether they are present in a manner that contributes to the OUV of the World Heritage Property. The assessment has been conducted by qualified experts in their respective fields and the Queensland Government has considered how best to accommodate port development now and into the future, while also achieving a net benefit for the GBRWHA. This is reflected in the offset strategy outlined in Section 5.2. The dredged material is proposed to be contained in the DMCP, which will be appropriately managed to ensure minimal impacts on the GBR as well as the adjacent Caley Valley Wetlands (refer to

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19 cont.			Section 4.1.1.3 of this report). Further, it is noted that further expansion at Abbot Point is aligned with the Queensland Ports Strategy which limits impacts to the GRBRWHA by confining development to existing and long-established major port areas within and adjoining the GBRWHA. This is now a matter for consideration by the Minister.
20	Queensland Conservation Council *Community / conservation group*	1. The dredging area is also home to juvenile and spawning fish. Disrupting their breeding cycles could affect the entire Reef's ecosystem, including coral reefs.	Refer to Sections 4.1.1.5 and 4.1.2.2
		2. Increased shipping associated with the expansion will increase risk of accidents and threaten marine ecosystems.	Refer to Section 4.1.2.12
		3. Of particular concern is the danger posed to whales and their calves that migrate through this area.	Refer to Section 4.1.2.5
		4. Wastewater from the disposal of dredge spoil will be discharged into the ocean and stormwater from the ponds into the wetland. It is not known whether this water contains contaminants; however, it likely contains significant amounts	The impacts of return water, including quality considerations are considered in detail in the draft EIS. Refer Section 4.1.1.3 in relation to management of stormwater from the DMCP.

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20 cont.		of sediment and nutrients.	
		5. Dredging of the seabed would destroy seagrass meadows that provide food for many marine animals, including rare and endangered Dugongs and sea turtles, and provide shelter for many fish species.	Refer to Sections 4.1.2.3 and 4.1.2.5
		6. The endangered Australian Painted Snipe has essential habitat within the Caley Valley Wetlands. Its safety is risked from the resultant wastewater pond failure, changes to groundwater hydrology and the noise and activity of the dumping project.	Refer to Sections 4.1.1.3 and 4.1.2.8
		7. Expansion of the port is to enable the export of coal. The burning of coal is the greatest contributor to climate change, which in turn is the greatest threat to the Reef. To damage the Reef for a dying industry would be illogical.	Refer to Section 4.1.2.10
21	GVK – Hancock *Industry stakeholder*	1. The DMCP must be consistent with industry best practice and therefore consider acceptable levels of liner permeability, adequate restraint of the liner, appropriate piping of water and sediment from the DMCP, mitigation of the risks of erosion of mud outside the DMCP, long-term management and disposition of material within the DMCP and geotechnical and hydrogeological stability issues beneath and in the vicinity of the DMCP.	The DMCP has been designed in an appropriate manner by qualified professionals, using recognised industry standards with the aim of meeting the objectives of the Project. The design is therefore considered fit for purpose.

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21 cont.		2. The Proponent must demonstrate that the DMCP will be a stable long-term structure. The design life must be for a minimum of approximately 30 years because it is not demonstrated how the DMCP can be removed in a shorter period.	Refer to Section 4.1.1.3
		3. The Proponent proposes a high risk containment structure, taking account of the severe consequences of structural failure, without full assessment of the long-term risks and issues. This does not satisfy the precautionary principle set out in Section 391 of the EPBC Act.	Refer to Section 4.1.1.3
		4. The DMCP will cause physical isolation of the Hancock Coal Infrastructure Pty Ltd (HCIPL) rail loop from T3. It therefore cannot remain long-term and must be removed.	The Project is relatively small scale and of short duration. The location of the DMCP was determined by available land that was outside the Caley Valley Wetlands and had minimal impact on existing and proposed infrastructure. However, it is acknowledged that the DMCP partly overlaps GVK Hancock's proposed T3. The DMCP has been designed, in discussion with GVK, so that the south-east section (i.e. the secondary pond) can be readily removed. Removal would involve ground restoration, such as accelerated dewatering and consolidation (e.g. wick drains, vacuum consolidation etc.) and blending of the coarser material with the finer material to improve the overall quality of the material as a foundation. Hereafter, any unsuitable material would be removed to an alternate site within the port, and reuse of the embankment

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21 cont.			material, or suitable dredged material, to backfill / elevate the DMCP footprint would be undertaken as necessary. This design element, combined with the short to medium-term life of the Project, means that conflicts with GVK Hancock's proposed T3 are likely to be avoided.
		5. Facilitated impacts to the hydrogeology in DMCP-adjacent areas were not assessed, e.g. increases in level, pressure and acidification, and hyper-salinity. This is a serious omission and must be rectified.	Refer to Section 4.1.1.3 The Groundwater Assessment Report (Volume 3, Appendix L) provides a detailed assessment that was undertaken to assess the predicted impact to the hydrogeology within the proposed DMCP and adjacent areas.
		6. The DMCP must not direct surface water into adjacent areas without strict water quality and water discharge obligations, and design measures to ensure the water runoff does not ingress adjacent to terminal areas.	Refer to Section 4.1.1.3
		7. The DMCP will cause significant impacts to the footprint of the approved HCIPL rail loop from substantial overlap, physical isolation of T3 from the HCIPL rail loop. This long-term impact cannot remain and the Proponent must resolve this.	The Project is relatively small scale and of short duration. The location of the DMCP was determined by available land that was outside the Caley Valley Wetlands and had minimal impact on existing and proposed infrastructure. However, it is acknowledged that the DMCP partly overlaps GVK Hancock's proposed T3. The DMCP has been designed so that the south-east section (i.e. the secondary pond) can be readily removed. This design element combined with the short to medium-term life of the Project means

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21 cont.			that conflicts with GVK Hancock's proposed T3 are likely to be avoided.
		8. The finer dredging sediments may have acid-forming potential, which might leave HCIPL with unsuitable fine material inside its rail loop without ability for reuse. The material must be removed.	The preliminary ASSMP in Volume 3, Appendix X of the draft EIS identifies contingency options in the event of observed acidic conditions: ▪ In-DMCP treatment by lime addition and mixing ▪ Excavation and treatment within the DMCP, redistribution and mixing ▪ Excavation and treatment external to the DMCP, redistribution and mixing.
		9. The EIS discusses potential cumulative impacts for a number of listed migratory shorebird species. The assessment indicates a low overall cumulative impact but suggests the HCIPL projects have the greatest potential for impact. This statement is not supported with data and cannot be verified.	Refer to Section 4.1.2.11
		10. The approval for T3 requires the action to fully reflect the findings of the final CIA Synthesis Report in developing a management and monitoring framework. However, it is now unclear how the Abbot Point Growth Gateway Project will impact the T3 project in respect of the CIA commitments and we request further clarification on this matter.	Refer to Section 4.1.2.11

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21 cont.		11. Appendix P2 in the EIS is not available. Please provide.	Appendix P2 was provided as part of Appendix P in Volume 3 of the draft EIS for ease of download and reading. The appendix is produced by ELA and is a memorandum titled *'Assessment of alternative pipeline alignments and soil stockpile/pipeline laydown area – terrestrial ecology'*. Please refer to http://www.statedevelopment.qld.gov.au/resources/project/abbot-point-apx/abbot-pt-eis-appendix-p-terrestrial-ecology-report.pdf for direct access to the appendix.
		12. The risk register in Appendix U is not complete as it does not explain the risk methodology and is unclear in how risk levels were determined or the overall development risk and failure consequences.	The EIS Guidelines require an evaluation of the potential environmental impacts using a risk based methodology. The risk approach and methodology applied to assess potential impacts is outlined in Section 4.2 of the draft EIS. The risk register (Volume 3, Appendix U) summarises the results of the environmental risk assessment. These results have been taken into account in the assessment of the Project's impacts on relevant MNES (Volume 2, Sections 4.5 to 4.8).
22	*Juru Enterprises Limited*	1. Draft EIS too large for download and too lengthy for proper review by Indigenous communities.	DSD recognises that internet connectivity and speed can be an issue for some communities, and the PDF versions of the draft EIS were compressed to the degree possible. Appendices were also split out from the main document to facilitate download. A hard copy of the draft EIS was made available at the State library in Bowen (and other areas) during the public exhibition period. It is appreciated that this documentation is lengthy and takes time to

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22 cont.			review. The Executive Summary was provided to ensure that a shorter document (25 pages) was available, which captured the main findings of the EIS process.
		2. Review timeframe not sufficient to review lengthy documents, particularly chapters related to cultural heritage.	Refer to Section 4.1.3.1
		3. Extensive use of technical language in the document limits ability to provide informed feedback. More use of diagrams and figures could have been made to adequately explain topics.	The Executive Summary contained in the draft EIS attempts to provide a non-technical summary of issues covered in the draft EIS to facilitate ease of understanding.
		4. There is a heavy reliance on expert advice which is highly academic in nature and has no reference point for a common interpretation.	The draft EIS has been prepared in direct response to DoE's EIS Guidelines (Volume 3, Appendix A). These guidelines outline the nature of technical investigations that must be carried out, and the manner in which information should be presented. Information has been presented simplistically wherever possible; however, this has not always been feasible given the technical nature of investigations being carried out and level of expert review required for assessment.
23	GE Water	Propose use of their services for dust suppression.	Noted
24	Climate Change Action	1. The Project enables the mining and burning of coal from the Carmichael Mine in the Galilee Basin, causing global warming in excess of Australia's commitment to a 2ºC	Refer to Section 4.1.2.10 Refer to Section 7 of the draft EIS (Volume 2) and Appendix I

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24 cont.	Network *Community / conservation group*	increase in temperature and thereby killing the GBR.	(Volume 3)
		2. The proposed dredging would facilitate further increases in CO_2 emissions resulting in increased ocean acidity which dissolves the coral and thus kills the GBR.	Refer to Section 4.1.2.10
		3. After the dredging debacle at Gladstone, the system has not been changed and we therefore have no confidence that the current proposed dredging arrangement would be managed responsibly.	It is noted that the impacts at Gladstone were related to the placement of dredged material, rather than the dredging operations themselves. In this context, this response addresses placement aspects. The design of the DMCP takes into account recent projects and incorporates lessons learnt. In particular, return waters within the DMCP will be monitored and treated, where required, prior to discharge. Part of the treatment process will include pH adjustment and settlement of fine sediment prior to release. Discharge through the bund system utilised in Gladstone is not proposed for the Project. The containment bunds in Gladstone were constructed offshore as part of a reclamation project and were not effectively lined. The internal batter of the external embankments of the DMCP will be lined to minimise leakage. Additionally, the DMCPs are onshore and not subject to tidal influence and other aspects that influenced the failure at Gladstone.
		4. The Carmichael Mine, for which the dredging is proposed, is not economic on any currently projected coal price. Hence the dredging project would be a dead loss and steal resources from worthwhile projects.	Refer to Section 4.1.1.1

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24 cont.		5. Seaborne coal, for which this dredging is presupposed, is in terminal decline with no sign of recovery due to many factors.	Refer to Section 4.1.1.1
		6. The Carmichael coal is low quality, low heating value and high ash. Some of it is half clay. It is not worth exporting and not worth dredging an extra port for.	Refer to Section 4.1.1.1
25	*Member of the public*	1. The consultation process was clearly designed to limit public input into any decision-making.	Refer to Section 4.1.3.1
		2. The proposed dredging operations will ensure large-scale dredging continually operating over time.	The existing berth pocket at T1 has only required two minor periods of maintenance dredging since its development. The first maintenance campaign occurred in 1986 and the second in 2008 when it was combined with the capital dredging for berth 2. This demonstrates that little transport and deposition of fine grained material into dredged areas has occurred at the port since initial port construction and supports the conclusion of CDM Smith (2013b) that maintenance dredging is not likely to be required (for the areas to be dredged as part of the Project) for up to 20 years, given the naturally deep characteristics of the Port. Should the requirement for maintenance dredging arise, the relevant approvals would be sought as necessary at that time.
		3. Sedimentation from dredging adversely impacts not only on water quality but also on the fauna and flora in the areas that	Refer to Sections 4.1.2.1 and 4.1.2.3

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25 cont.		it reaches, smothering both seagrass and corals.	
		4. Along with the sedimentation produced, the dredging itself would be destructive and destroy sections of the Reef.	Refer to Sections 4.1.2.1 and 4.1.2.3
		5. The dredged seafloor will be dumped on the Caley Valley Wetlands, which are a significant wetland that form a natural filter for the Reef and which also form vital fish nursery and bird habitat. It qualifies as a RAMSAR wetland.	Refer to Section 0
		6. The adverse impacts on the wetland from dredging and associated coal port activities would affect the OUV of the GBR.	Refer to Section 0
		7. The long-term future of coal mining being a viable economic activity is acknowledged to be low.	Refer to Section 4.1.1.1
		8. The coal industry employs a very small number of the Australian workforce, data on indirect jobs generated are completely inflated and biased, and fiscal revenue from coal mining is low. Industries relying on a healthy GBR represent a much larger economy and are put at risk from dredging near the GBR.	Refer to Section 4.1.2.13
		9. Australians have overwhelmingly shown that they want the Reef to be protected and maintained, yet the Federal	The Proponent has undertaken a draft EIS in accordance with the EIS Guidelines. The merits of the proposal are now a matter for

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25 cont.		Government has simply treated these citizens with contempt. The desires of big business mates and possible political donations should not be given priority over the community's wishes.	consideration of the Minister.
		10. Not only does the dredging alone endanger these ecosystems more coal mining increases climate change - which is already impacting the planet adversely.	Refer to Section 4.1.2.10
		11. Empirical historical record of shipping demonstrates that the vastly increased shipping rates associated with the Abbot Point development shall add greatly to the risks of shipwrecks and pollution detrimentally affecting the Reef.	Refer to Section 4.1.2.12
26	*Member of the public*	1. The Economic Impact Assessment presented in the EIS has a range of deficiencies, and is generally considered inadequate, and is not focussed appropriately. The economic report does not meet the criteria for a balanced and useful report on the risks and benefits of the proposed Project.	The submission contends that the economic impact assessment does not consider the potential adverse impacts of the risks associated with increased shipping through the GBR, and the consequent impacts of adverse events on the tourism and fishing industry. Shipping within the GBRMP is highly regulated both in terms of approved passages through the Reef and ship operation (e.g. pilotage). The economic analysis assumes that regulatory settings are effective in mitigating such risks.
		2. It is considered that the assessment should be focussed on the following questions:	The purpose of the economic impact assessment is to consider the impacts on the economic environment of the Project as opposed to

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26 cont.		a. Is the unmitigated risk posed by the Carmichael project for which this expansion is required, guaranteed to be sufficiently lucrative to justify the risk of damage to the coastal area and the GBR? b. If there is damage to the Reef, what might be the consequential cost of the environmental damage to other established industries in Queensland?	other projects. Advice from NQBP is that the current capacity of the Port of Abbot Point (~50Mtpa) is already fully contracted for outputs from existing Bowen Basin mines. Any development of additional coal mines within the catchment of the Port of Abbot Point will require augmentation of port capacity. Shipping within the GBR is subject to regulatory controls independent of the Project. It is assumed that these measures are effective in mitigating shipping risks. The Project is anticipated to have a capital cost of between $50 million and $100 million. In an economic context, this represents a small project, with a capital cost similar to the construction of a grade separated road crossing. Given the scale of the Project, it is highly unlikely that it would have any material adverse economic impacts on the local, regional or Queensland economy.
27	Queensland Wader Study Group *Independent researcher*	1. Wader birds were surveyed only within the project area (including the Caley Valley Wetlands) and surveys did not take into account the well-known movements of shorebirds between habitats.	Refer to 4.1.2.4
		2. The EIS does not include details of the tide heights during the surveys. If the surveys were not undertaken at spring high	Refer to Section 4.1.2.4

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27 cont.		tides (rather than neap tides) then the number of shorebirds in the project area will be under-estimated.	
		3. Inadequate concern has been given to the impacts associated with disturbance to shorebirds during construction and ongoing disturbance from wind-blown dust and noise.	Refer to Section 4.1.2.8
		4. Changing coastal dynamics as a result of the Project, in combination with the effects of climate change, may result in future impacts to the wetland from tidal inundation, and flooding of port infrastructure and the DMCP, leading to loss of containment of dredge spoil.	This has been addressed by the design of the DMCP embankment, based on extreme water level advice from BMTWBM (*2014 coastal inputs – Abbot Point approvals project risk analysis of dredge material containment*). The toe of the DMCP embankment is above the 0.1% Average Exceedance Probability (1:1000) climate change scenario combined surge, tide and climate change level of RL3.39m Australian Height Datum (AHD), with the exception of a small length of the DMCP embankment (i.e. along the northern embankment with a low of RL2.65m AHD), which is above the 0.1% (1:1000) existing scenario tropical cyclone induced extreme water level of RL2.44m AHD.
28	*Member of the public*	1. Concerns raised on the conflict of interest that the Government has, considering it is both the Proponent and responsible for assessing the proposal. They also appear to be publishing biased information in their website.	Refer to Section 4.1.3.2
		2. No assessment of the extended trestle option as an alternative option to dredging.	Refer to Section 4.1.1.2

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28 cont.		3. Concerns around the bias and credibility of the environmental impact assessment process, such as the selection of consultants who may not be independent.	Refer to Section 4.1.3.2
29	Whitsunday Residents Against Dumping *Community / conservation group*	1. Lack of demonstrated need for a port expansion at the Port of Abbot Point as this facility currently operates well below capacity and there is a systemic decline in the coal industry globally.	Refer to Section 4.1.1.1
		2. Concerned at the lack of employment opportunities presented for local communities.	The draft EIS outlines that a peak of 164 workers will be required during the construction period of the Project. The Project by its very nature is a short-term dredging program that does not directly provide substantial long-term opportunities.. The recruitment strategy for the Project will follow a local-regional-State-national hierarchy, giving preference to those workers who reside locally. The appointed contractors will be required to adhere to this approach, and outline their local recruitment strategy for the Project. This may include opportunities to upskill, train and further develop local workers to equip them to access project employment opportunities.
		3. Dredging impacts – concern that the dredge plume will impact seagrass and coral communities.	Refer to Section 4.1.2.1
		4. Pipeline corridor – 12m wide disturbance will lead to	The pipeline alignment includes a variety of landforms, including car

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29 cont.		impacts on plants and habitat, as well as an increase in runoff and soil degradation.	parks, laydown areas, settlement ponds and roads that may support small areas of non-remnant vegetation. There is an area of 0.1ha of foredune vegetation that is mapped as remnant, although this area is highly disturbed. No vegetation or habitat within the pipeline alignment has been identified as representing habitat for EPBC-listed species, and the route has specifically been selected to avoid disturbance to remnant vegetation.
		5. The potential for overflow, and the lack of a pond floor liner raise concerns in terms of the potential impact to the Caley Valley Wetlands and adjacent marine environments.	Refer to Section 4.1.1.3 Refer to Section 4.1.1.3 and 4.1.1.4
		6. There is the potential for ASS and other contaminants to be mobilised during dredging.	Refer to Section 4.1.1.4
		7. There are a number of issues associated with increased shipping, including: a. Increased turbidity b. Increase in marine strikes on marine life c. Heightened risk of reef groundings	Refer to Section 4.1.2.12
30	*Member of the public*	1. Risk assessment does not appropriately categorise risks related to: a. ASS associated with the dredged material. b. ASS associated with the DMCP footprint. c. Groundwater and release of metals and metalloids	The risk assessment methodology, including definition of risk categories has been developed in line with established guidelines and standards. The assessment has been conducted by qualified specialists in their respective fields.

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30 cont.		and/or organic compounds. d. Aquatic ecology impacts associated with the overflow of pond storage. e. Sediment and erosion associated with works.	
		2. Concern expressed at the proposed water use at Carmichael Mine.	This comment relates to Adani's proposed Carmichael Coal Mine and Rail project and is outside the scope of the draft EIS and responsibility of the Proponent of the Project.
		3. General concern regarding potential impacts on the GBR, specifically the impacts on "reef-associated" fish populations, and on seagrass communities.	Refer to Sections 4.1.2.1 and 4.1.2.3
31	*Member of the public*	1. Abbot Point expansion is only justifiable if the rail link to the Adani Carmichael Coal Mine is in place and the mine is operating profitably.	Refer to Section 4.1.1.1
		2. The purported jobs to be created by the Carmichael Mine are considered inaccurate.	This comment relates to Adani's proposed Carmichael Coal Mine and Rail project and cannot be responded to by the Proponent of the Project.
		3. The Carmichael Mine will have an unacceptable impact on groundwater in the area.	This comment relates to Adani's proposed Carmichael Coal Mine and Rail project and cannot be responded to by the Proponent of the Project.
		4. Dredging will impact on seagrass meadows, upon which	Refer to Sections 4.1.2.1, 4.1.2.3 and 4.1.2.5

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31 cont.		many marine animals depend.	
		5. Dredging plume may impact on adjacent reef and seagrass communities.	Refer to Sections 4.1.2.1 and 4.1.2.3
		6. Dredged material to be contained within the DMCP may have PASS that can become very acidic when exposed to air; or other potential contaminants associated with industrial and port operations.	The ASSMP (Volume 3, Appendix X) identifies the Proponent's commitments to mitigation strategies: ▪ Strategies to be reviewed and updated if self-neutralising ASS is not confirmed. ▪ Lime guard layer to be placed over the base of the secondary DMCP. ▪ Phased characterisation/verification testing of placed dredged material, by visual identification, field screening and subsequent laboratory testing, if warranted. Initial focus on fine materials segregated during placement. Strategies to be reviewed and updated if a higher level of risk is indicated. ▪ Groundwater quality monitoring surrounding the DMCP. ▪ Return water monitoring and management. Refer to Section 4.1.1.4
		7. The potential for overflow, and the lack of a pond floor liner raise concerns in terms of the potential impact to the Caley Valley Wetlands, adjacent marine environments, and associated species.	Refer to Section 4.1.1.3

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31 cont.		8. Birds species will likely be impacted by changes in the wetland, associated with salinity groundwater seepage and potential overflow from the DMCP.	Refer to Sections 4.1.1.3 and 4.1.2.8 Section 4.3.6.3 of the draft EIS provides the results of the assessment that takes into account the groundwater modelling results for the Project. The modelling showed that under worst-case conditions, the greatest change to salinity would be experienced immediately adjacent to the DMCP where salinity may increase by up to 3ppt above background conditions. This increase is small when compared to the natural (seasonal) variations of salinity experienced in the wetland. The assessment concludes that the results of the realistic and worst-case wetland hydrology scenarios indicate that persistent detrimental impact on aquatic flora and fauna within the 'wetted' sections is not expected to occur due to operation of the DCMP, and that any impacts to aquatic communities are expected to be short-term, with rapid recovery occurring in the next wet season following the completion of works. Any such, localised, minor and short-term impacts on the aquatic environment would not have a discernible impact on birds utilising the extensive wetland habitats. While considered unlikely due to the implementation of management measures to prevent such occurrences, an event that resulted in overflow from the DMCP may cause very localised scouring. Any scouring would be remediated immediately as part of the environmental management regime.

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31 cont.			
		9. Increased coal dust may also harm the wetland.	Refer to Section 4.1.2.8
		10. GHG emissions associated with the burning of coal facilitated by the Project means the Project is not responsible.	Refer to Section 4.1.2.10
		11. There are issues with the increased shipping, including: a. Increased turbidity. b. Damage to the seafloor due to anchoring. c. Increased risk of groundings, oil spills and the introduction of alien species through bilge water.	Refer to Section 4.1.2.12
32	*Member of the public*	3. Dredging plume and impacts on the adjacent marine ecosystems.	Refer to Section 4.1.2.1 and 4.1.2.12
		4. Removal of seagrass and its impacts on associated species such as Dugong and turtles.	Refer to Sections 4.1.2.1, 4.1.2.3 and 4.1.2.4
		5. Proximity of the DMCP to the wetland and the GBRMP, and the potential for wastewater overflow to impact on sensitive receiving environments and associated species.	Refer to Section 4.1.1.3
		6. Concerned that the reef is already under pressure from agriculture and land runoff.	Runoff from land-based activities has been recognised by the Australian Government to be one of the contributing factors to

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32 cont.			impacts on the Reef. While this is not a matter for consideration by this Project, the Australian Government is seeking to reduce land-based runoff, including through the use of the Reef Trust, to which a contribution is proposed to be made as part of the Project's offset strategy.
		7. Additional shipping presents additional risk to the Reef, as a result of potential spills or shipping accidents.	Refer to Section 4.1.2.12
		8. Climate change – the Project does not represent a socially responsible option for energy provision, as it will facilitate the export of coal (a fossil fuel).	Refer to Section 4.1.2.10
33	TJ Ryan Foundation *Independent researcher*	1. Submission provides information intended to help other people wishing to provide comments on the Project, but it addresses broader issues associated with the Carmichael Coal Mine development, and does not focus on the Abbot Point port expansion directly.	Noted.
		2. General issues around the Project supporting further coal development, thereby impacting climate change and going against Australia's emissions targets and commitments in this regard.	Refer to Section 4.1.2.10
34	*Member of the public*	1. Dredging will disturb the seabed and create plumes which may damage corals reefs.	Refer to Section 4.1.2.1

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34 cont.		2. Digging up seabed will create plumes which can travel greater distances than previously thought, of up to 100km in which is within reach of the marine park.	Refer to Section 4.1.2.1
		3. Seagrass meadows provide important ecosystem services (Waycott *et al*, 2008).	Refer to Section 4.1.2.4
		4. Studies have proven seagrass to be important 'carbon sinks' for absorbing carbon dioxide. Considering this Project is removing important seagrass beds and increasing the levels of GHG in the atmosphere (by supporting the increased use of fossil fuels), these are two actions which contradict Australia's move towards reducing emissions.	Refer to Section 4.1.2.3 and 4.1.2.10
35	*Member of the public*	1. According to mapping, the port is clearly in the middle of (not on the edge of) the GBRMP. Increased shipping will plough through the heart of the reserve.	Refer to Section 4.1.2.12
		2. The construction of the holding pond walls out of dredged material, which is likely to include ASS, does not imbue one with much confidence as to their sturdiness or fitness for purpose. They are right adjacent to the wetland which are thus at direct risk from any leakage.	Refer to Section 4.1.1.3
		3. The *"anticipated economic benefits"* of some $35 million a year sound highly optimistic given the falling price of coal,	The source of the reference to anticipated economic benefits of $35 million is unclear. The construction and operation of the Project is

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35 cont.		and how these will benefit *"all of Australia"* is a mystery hard to believe. Whether these supposed benefits will offset the cost of damage to the GBR is not discussed.	anticipated to stimulate economic activity within the Mackay, Isaac and Whitsunday region, and facilitate additional exports of up to 70Mtpa of coal. Direct risks to the GBR associated with shipping are subject to a range of regulatory controls independent of the Project.
		4. The report lists many species using the land and waters around the port, but dismisses any impact of development as insignificant. Given the scale of operations this is hard to credit; both civil works and operational ports are loud and messy and will certainly adversely affect the local environment in both the short and long-term.	The draft EIS assessed all potential environmental values at Abbot Point in line with the EIS Guidelines for the Project and *Significant Impact Guidelines 1.1* (DoE, 2013). The results of the assessment are now a matter for consideration by the Minister.
		5. A *"range of mitigation processes"* is proposed with no detail provided, with these being said to cancel any need for offsets. This over-optimistic assumption seems to fly in the face of the track record of such projects to date.	There will be no removal of wetland habitat and no significant or long-term impacts are predicted for the ecosystems or species of the Caley Valley Wetlands for this short-duration Project. As such, no offsets are required. Details of impact mitigation processes for each impact type are described by ELA (2015) (Volume 3, Appendix P), discussed in the impact assessment sections (Section 4.4.6 and 4.4.7), and summarised in the draft EIS (Volume 2, Section 3.1).
		6. It is appreciated that the proposed method of dredging is better than previous proposals, but even the improved version expects around 10,000t of silt to escape into reef waters; a pretty poor "win".	Comment noted. This is now a matter for consideration by the Minister.
		7. My main objection is that the report starts off by listing the	The draft EIS assessed all potential environmental values at Abbot

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35 cont.		key risks to the Reef, and then arguing that this development will only be imposing minor ones by comparison. The whole point of the development is to increase the use of coal which will directly increase the major threats first listed, particularly 'increasing sea temperatures'. Thus whatever the "*lesser, localised impacts"* are they are part of an entirely flawed strategy that continues to threaten the Reef.	Point in line with the EIS Guidelines for the Project and *Significant Impact Guidelines 1.1* (DoE, 2013). It includes discussion of impacts of the associated Carmichael Coal and Rail project. This information is now a matter for consideration by the Minister.
36	*Member of the public*	1. The EIS is vague in relation to job opportunities to be created by the Project in the region. Job creation is consistently inflated by proponents who fail to account for the loss of jobs in other sectors. In Bowen, job creation for the Project is likely to lead to the loss of jobs in the tourism and fisheries sectors, two sectors which will not be able to cohabitate with a major dirty coal export point.	The Project is realistic about the short-term nature of job opportunities that will be created directly by the Project (i.e. a peak of 164 full time equivalent positions over the period of DMCP construction and dredging). These opportunities may result from either new employment positions or additional shifts for existing (contract) workers. Loss of jobs in other sectors such as tourism and fisheries cannot be calculated with any level of accuracy given the number of external factors involved in such a calculation. For example, there are a multitude of reasons why fish stocks may dwindle or the region becomes unattractive to visitors (e.g. cyclones or severe weather, political unrest, economic challenges). Given the short duration of the dredging program, it is anticipated that the fishing and tourism sectors will be able to co-exist with development activities at Abbot Point over the long-term.
		2. The Project's viability will rely on its use by exporters of coal	Refer to Section 4.1.1.1

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36 cont.		mined in the Galilee Basin. Given the speed at which coal is losing its value, banks are running away from Adani, companies all over the world are divesting from their coal assets and people across the world are embracing new green technologies, the Project's viability is likely to be short-term, while environmental impacts will be long-lasting.	
		3. The Project will facilitate the extraction, export and overseas use of large quantities of coal, and hence directly contribute to increased greenhouse emissions overseas and climate change for the whole world. This in turn will contribute to the adverse impact on the GBR.	Refer to Section 4.1.2.10
		4. The Commonwealth and Queensland Government have treated the Reef with contempt over the past decades and it is time that these governments take their responsibility to protect the Reef seriously. Port development, particularly any that is associated with dirty greenhouse emissions industries like coal mining and exporting must not be permitted.	The draft EIS assessed all potential environmental values at Abbot Point in line with the EIS Guidelines for the Project and *Significant Impact Guidelines 1.1* (DoE, 2013). It includes discussion of impacts of the associated Carmichael Coal and Rail project, NGBR Project and Abbot Point T0 project. This information is now a matter for consideration by the Minister.
		5. The proposed mitigations measures to reduce impacts on the Australian Painted Snipe are not suitable. Close to a development of this magnitude and nature, the Painted Snipe and other migratory species will be deeply compromised.	There is no proposed wetland habitat loss or removal as a result of the Project and anthropogenic disturbance will be confined to the short–term construction period. Impact mitigation measures are proposed to reduce the impacts of this disturbance so that effects on the Australian Painted Snipe, should they be present during the

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36 cont.			construction period, are minor. The final EMP for the Project will be developed incorporating appropriate measures to mitigate and monitor potential impacts on the Australian Painted Snipe and migratory shorebirds due to facility construction, and operations post the construction and dredging phases.
		6. The direct and indirect impacts of the dredging spoil on the nearby Caley Valley Wetlands are of concern. It is likely that the dumping of ASS will at some stage leak, affect groundwater, and/or be redistributed on the wetland in cases of severe cyclones and storm surges.	Refer to Sections 4.1.1.3 and 4.1.1.4
		7. The impact of greatly increased shipping traffic in the area is a great concern that cannot be mitigated. The EIS Executive Summary's statement that *'[w]ith a high level of confidence, it is considered that the cumulative impacts of shipping on the Outstanding Universal Values of the Great Barrier Reef World Heritage Area have been comprehensively addressed and are being acted upon by the Australian and Queensland governments and industry bodies'* is arrogant and ignorant.	Refer to Section 4.1.2.12
		8. Do not believe that *'the Project will provide a net benefit for the Great Barrier Reef World Heritage Area'*.	The Project has been assessed as having no significant residual impact on the GBRWHA. The *Reef 2015 Long-Term Sustainability Plan* has determined that wherever projects occur within the

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36 cont.			GBRWHA, they should achieve a net benefit outcome. While the offset strategy is yet to be finalised, it is intended that the Proponent will contribute funds to undertake sediment control actions in the GBRWHA catchment via the Reef Trust mechanism. The Trust is designed to target key threats to the Reef's water quality, and particularly diffuse source pollution from broadscale land use as directed by the *Reef Water Quality Protection Plan 2013*. There is no proposal to place dredged material within the GBRHWA. Actions to prevent more fine sediment entering the GBRWHA than would be mobilised by the proposed CSD process and placement of dredged material in an onshore facility will result in a net benefit outcome.
37	*Member of the public*	1. If as governments you accept the science of climate change you then, logically, accept the science that says in order to avoid runaway climate change, 80% of fossil fuel reserves must remain in the ground. That means the Galilee Basin cannot be exploited. Therefore this development must be refused.	Refer to Section 4.1.2.10
		2. If you accept that current financial and economic realities relating to coal prices and structural reform of energy and production in both China and India, you should refuse this development. Adani has been seeking handouts and subsidies from the beginning. Royalty holidays and taxpayer money poured into a rail line that can only be used for coal are only the latest effort of Adani to secure	Refer to Section 4.1.1.1

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37 cont.		corporate welfare. Approval of dumping and dredging at Abbot Point must be understood to mean approval of the Carmichael Mine and the rail line. The exposure of the Government will be massive.	
		3. This is now the third EIA I have commented on for development at Abbot Point. Submissions to these developments have made no difference whatsoever to the process or conclusions reached by government. The former Prime Minister made it clear this development will proceed regardless of public input or public opposition. He made clear that the Carmichael Mine will proceed. One can only hope that the current PM looks closely at the business case against these developments before he allows this development to be approved.	Noted and now a matter for consideration by the Minister.
		4. Current proposal contains no new information regarding the possibility of a new species – the Irawaddy River Dolphin, although it was raised as an issue in previous iterations of the Project. If this process is going to have scientific integrity then the lack of information and data on these species (and others) must result in either a requirement that necessary data is secured or a precautionary approach.	The Irrawaddy River dolphin is found in coastal areas of South East Asia only. The inshore dolphin species that are found in Australia Waters are the Info-Pacific Humpback and Australian Snubfin dolphins. These two inshore dolphins are assessed in the draft EIS. Refer to Sections 4.1.2.4 and 4.1.2.5
		5. This iteration of the Project proposes a larger stockpile at Abbot Point, and coal dust from trains and loading will	The draft EIS (Volume 2, Section 4.3.2 and Volume 3, Appendix H) assesses air quality impacts of the Project. Dust level predictions

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37 cont.		increase. However, the EIS does not deal with associated issues including potential exceedance of allowable limits for a number of metals in fresh and salt water.	have been considered within the ecological assessment (Volume 2, Sections 4.3.7 and 4.5). The Project will not result in any direct emission of coal dust. However, it is acknowledged that the impacts of the associated T0 project will include impacts in related to coal dust emissions. These impacts are noted in the Air Quality Technical Assessment (Volume 3, Appendix Q, Section 6.2) based on the assessment undertaken for the T0 EIS (CDM Smith, 2013a).
		6. This iteration of the Project has failed to assess underwater noise associated with operation, i.e. ship noise. There is the possibility of significant impacts on marine life from noise and the view of the United Nations Environment Programme (UNEP) is that the issue of marine noise from shipping is an 'urgent' one.	Project-associated shipping noise is confined to the dredging phase and has been assessed in the draft EIS (Volume 2, Section 4.3.3). Information on shipping noise associated with the operation of the related Abbot Point T0 project is provided in Volume 2, Section 6.3.3.5.
		7. A critical question to ask about the EPBC Act and the 5,500 approvals granted under that Act (and a handful of rejections) is whether the implementation of that Act is working to fulfil the objectives of the Act? The answer is a clear and irrefutable 'no.' Is the Act or its implementation capable of dealing with the realities of climate change on matters of national environmental significance, particularly the rapidly accelerating declines that climate change is bringing? Not without significant changes to the business as usual model that currently operates.	The Proponent has prepared a draft EIS in response to the DoE's EIS Guidelines (Volume 3, Appendix A). The efficacy of the Act as a matter for consideration is beyond the scope of the draft EIS.

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37 cont.		8. State and Federal Governments should know the perilous state of the GBR, and the potential impacts of climate change on coral communities and other calcareous creatures. Increased resilience of the Reef is the only way to give the GBRMP any chance of surviving. This proposal will reduce not increase resilience and significantly increase the amount of Australian coal being burned globally – further reducing the Reef's chances of survival.	Refer to Section 4.1.2.10
		9. Offsets are a bald faced scam, which the recent Senate Inquiry made very clear are not supported by good science or much of any science at all.	The assessment of impacts of the Project on MNES determined that there are no significant residual impacts that would require offsetting. However, the Reef 2050 Plan indicates that where any projects occur within the GBRWHA, a net benefit should be sought. It is proposed that a net benefit will be provided by the Project through its contribution to the Reef Trust mechanism. The Trust has been established to deliver funding to projects that address key threats to the GBRWHA, and specifically to ensure that the funding is directed to a reduction in fine sediment entering the GBRWHA from the Burdekin River or Don River catchments in excess (>50%) of that mobilised by the proposed dredging.
38	*Member of the public*	1. The EIS assumes that the development will be approved/is approved and focuses on minimisation and offset rather than whether the development is justified economically and	The Proponent has prepared a draft EIS in response to the DoE's EIS Guidelines (Volume 3, Appendix A). The social, environmental and economic merits or otherwise of the Project will now be

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38 cont.		socially or acceptable environmentally.	considered by the Minister.
		2. The method for cumulative assessment is flawed.	Refer to Section 4.1.2.11
		3. The independence of government is questioned and this is an opportunity to ask why independent accredited (CEnvP) assessors are not used rather than government officers. Or at least that both consultants responsible for content and government approval officers be required to be CEnvP accredited.	Refer to Section 4.1.3.2
		4. EIS does not present detailed information around the impacts of returned water from de-watered dredge into the marine environment.	The sediment deposition areas of impact surrounding the return water discharge point were predicted based on the GBRMPA Water Quality Guidelines for sedimentation rates (both maximum daily and annual) and the light requirements for Abbot Point nearshore seagrasses. The methods and results in regards to sedimentation deposition (and light requirements) are outlined in Section 2.3 and Section 6.2 of The Marine Ecology Technical Report (Volume 3, Appendix Q1). These sections also outline the methods (and results) in regards to elevated TSS, increases in bed thickness and reduction in benthic light availability. The TSS and seagrass light requirement thresholds are based on measured data from the inshore areas at Abbot Point and are specific to this area. The hourly time series data from the modelling predictions of TSS, sedimentation and bed thickness in areas surrounding the return water discharge point and dredging area are outlined in Figures 6-

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38 cont.			24 to Figure 6-50, Section 6.2.5 of the Marine Ecology Technical Report (Volume 3, Appendix Q1). This information is an effective way of visualising what the conditions will be in terms of these parameters at varying distance from the impact points, in particular the discharge locations (refer time series data and graphs for Return Point OF1 to OF6). The box plot (Figure 6-35) in Section 6.2.5 of the Marine Ecology Technical Report (Volume 3, Appendix Q1) compares the background TSS data (median, 20^{th}, 80^{th} and 95^{th} percentiles) measured over the last 3.5 years at a range of sites at Abbot Point with the predicted TSS data at the discharge point and a various distances away from this point. At all sites, apart from the actual return water discharge point, the TSS concentrations quickly dissipates from the 100mg/L TSS concentration to below the GBRMPA Guideline value for open coastal of 2mg/L. The discharge water quickly dilutes to below background within 15m to 60m of the discharge point, depending on the tidal and current regime at that time (see Section 4.2 of the Hydrodynamic Modelling Report [Volume 3, Appendix N] for more details). There are no sensitive receptors within 100m of the discharge location.
		5. The scope of work is highly focused on the development stage and not the operational stage and makes large assumptions or fails to address the 50+ year operational life and decommissioning of the facility.	The construction of the Project is relatively small scale and of short duration (Volume 2, Section 2.3 of the draft EIS provides details). Following completion of dredging operations, the dredge plant and associated pipelines will be demobilised and removed, with only the

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38 cont.			DMCP remaining. The DMCP has a design life of 10 years, which will be further defined during the design phase. At or prior to the end of the design life, the DMCP may be decommissioned. No specific post-decommissioning end use for the DMCP site has been determined, due to the timelines involved. Decommissioning timing and future uses of the DMCP site will be defined by market conditions and demand for industrial development sites at Abbot Point. Therefore, it is not appropriate to specify timeframes for the decommissioning of the DMCP at this point. However, the end use of the DMCP site must be consistent with the planning scheme intent for the area in effect at that point in time. The Proponent commits to meeting with regulatory agencies two years prior to the end of the design life of the DMCP to discuss draft concept plans for decommissioning and possible end use of the site, and the concept plan's consistency with the planning intent for the locality. These will be documented in a decommissioning plan to be approved prior to the end of the DMCP design life (refer Volume 2, Section 2.2 of the draft EIS for further detail).
		6. The opportunity to look at restoration of the Caley Valley Wetlands has not been explored.	Refer to Section 0 Restoration of the wetlands is outside the scope of this Project and has accordingly not been explored. The Project's design and environmental management measures will ensure that no significant

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38 cont.			residual impacts to the wetland will occur.
		7. The pH and heavy metal issues are potentially underestimated.	In the absence of further context in the comment in relation to this matter, we infer that it relates to the subsequent matter (refer question 22) raised in the submission. Refer to the response issue 38.22 in this table.
		8. There is an implicit assumption in the EIS that because dredging or port development is not 'the largest threat' to the National Estate as a whole or the GBRWHA that that means that it is acceptable to proceed with the development. Comparison with other impacts is irrelevant except in as far as they represent a cumulative effect and therefore require the assessment and approval to exercise a higher rather than a lower degree of caution.	The Proponent has prepared a draft EIS in response to the DoE's EIS Guidelines (Volume 3, Appendix A). Impacts on MNES have been assessed in accordance with the MNES Significant Impact Guidelines (DoE 2013a) and not on a comparative basis against other threats to the National Estate or the GBRWHA. Assumptions utilised in the assessment are clearly stated in the draft EIS and its technical reports.
		9. The approval test should be based on whether likely or potential impacts are significant and therefore unacceptable or alternatively unnecessary because they are manageable with control provisions. The EIS fails to clearly identify and articulate the list (summary) of acceptance criteria and demonstrate how the development will perform against each criterion.	The Proponent has prepared a draft EIS in response to DoE's EIS Guidelines (Volume 3, Appendix A). Impacts on MNES have been assessed in accordance with the MNES Significant Impact Guidelines (DoE 2013a). The assessment and 'approval test' is a matter for consideration by the Minister.
		10. Do government proponents have an obligation to go beyond the legal requirement?	The Proponent is committed to responsible and effective environmental management. The draft EIS provides information on

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38 cont.			the broad social and economic impacts (positive and negative) of the Project. This information is now a matter for consideration by the Minister.
		11. The State of Queensland as the Proponent of the development has a conflict of interest in any assessment or approval of the EIS. So despite the accreditation of the State for assessment under the EPBC Act all approvals should be done at a Federal level.	Refer to Section 4.1.3.2
		12. As a financier and open political supporter of the Project the Federal Government has a conflict of interest in assessment and approval of the EIS and should appoint an independent team of accredited environmental experts rather than use paid government officials to undertake the formal assessment and make recommendations on the approval process.	Refer to Section 4.1.3.2
		13. If this project proceeds there will be impacts. The reversibility (life cycle rehabilitation), benefits of proceeding (to Australia) and alternatives (Investment in clean energy economy) have not been addressed or clearly and comprehensively articulated.	The Project's design, environmental management and mitigation measures, and offsets strategy ensure the Project is unlikely to have a significant adverse impact on MNES. Refer to Section 4.1.1.2 for a discussion of project alternatives.
		14. To claim this is a "short duration" Project and separate it from a process of infrastructure and mine development	The draft EIS (Volume 2, Section 6.2) provides information on the impacts associated with the related Adani mining, rail and port

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38 cont.		which will impact the landscape operationally for 50 years and leave a legacy impact is misleading.	developments. This information is now a matter for consideration by the Minister.
		15. The advantages of economic return are stated as inevitable, but must be regarded a significant risk in the context of current global economic trends for fossil fuels, coal and alternative energies.	Refer to Section 4.1.1.1
		16. If the Project is considered to be of short duration and low environmental impact; the same assessment frames (time and scale) need to be used for assessment of economic benefits.	The assessment of project impacts is confined to the construction and operating phase of the Project. The economic impact assessment provides estimates of the value of coal exports that could be facilitated by the Project in the context that it is part of a broader coal export chain.
		17. The Federal and State Government have an obligation to provide for the protection of the Reef and to offset impacts that cannot be attributed to personal or private company interests. Funding should occur directly and not as an offset funded by government. Any offset should be wholly funded by the private beneficiaries.	The Project is to be funded by the Galilee Basin project proponents on a commercial basis. The Proponent has in place appropriate commercial arrangements for the funding of the design and planning phase of the Project. The Proponent will put in place appropriate commercial arrangements with the port users in relation to funding the construction phase of the Project, including any conditions of approval such as environmental offsets.
		18. *"Bowen has experienced slightly lower growth when compared to the Whitsunday Local Government Area and the State of Queensland in recent years, likely due to the*	Refer to Section 4.1.1.1

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38 cont.		*downturn in the mining industry and the delays to the Port of Abbot Point expansion. This has resulted in high unemployment rates."* This demonstrates a clear bias and misinformation. If the mining industry is in decline this places into question the need for expansion of the port and raises the question of risk of stranded assets and loss of newly created jobs.	
		19. Growth is growth. The claim that growth equates with a high unemployment rate is false logic. Unemployment is attributed to the closure of existing industries not to the failure to create new ones by a given date.	To clarify the interpretation of this text, the sentence can be reworded as follows: *"Bowen has experienced slightly lower population growth when compared to the Whitsunday Local Government Area and the State of Queensland in recent years, likely due to the downturn in the mining industry and the delays to the Port of Abbot Point expansion. The abandonment or delay of a number of resources projects in the region has resulted in rising unemployment rates."*
		20. *"The Project will neither have significant impact on the visual amenity of the Abbot Point area, nor on marine mammals and birds frequenting the Caley Valley Wetlands."* I do not believe that this statement is justified either for during the project construction or for the operational stage of the port. The activities of port operation and shipping in direct proximity to the breeding and feeding grounds of avian and marine species cannot be considered to simply be inconsequential to these species. If the impact were	The assessment of impacts of the Project on the OUV associated with the GBRWHA has taken into account all potential risks and residual impacts associated with the Project on those OUVs expressed at the Port of Abbot Point, and specifically for visual amenity (aesthetics), marine mammals and birds within the Caley Valley Wetlands (refer to Section 3.2.6 and Section 4.6 of the draft EIS). The Project is consistent with the recommendations of the *Reef*

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38 cont.		inconsequential this would imply that development of a hundred similar ports along the coast line would not matter. This ignores the cumulative effect of a threatened system and context of other "insignificant" impacts.	*2050 Long-Term Sustainability Plan* where the proposed short-term dredging action is confined to a Priority Port Development Area and beneficial reuse of dredged material is planned. All potential risks on the values of the GBRWHA associated with the Project have been addressed. As concluded in Section 4.6.5 of the draft EIS, the impacts of the Project on the values of the GBRWHA and National Heritage Place are localised and are mostly temporary in nature. When the proposal to achieve a net benefit for water quality and seagrass in the region is considered, overall it is highly unlikely that there will be a loss of OUV or a decline in the integrity of the GBRWHA as a result of the Project. The assessment of cumulative impacts, incorporating those impacts that result from the successive, incremental and/or combined effects of the Project when added to other existing, planned and/or reasonably anticipated future projects, includes an assessment of cumulative impacts on OUVs expressed at Abbot Point (Section 6.3.4).
		21. *"Considering the location of the Project, the type of dredge proposed to be used, the onshore placement of dredged material, as well as the planned mitigation measures, residual risks of indirect impacts from project activities are considered low."* This is a misuse of criteria for the assessment of impacts. The location, type of dredge and method of placement or the provision (not planning) for mitigation are irrelevant. Further it is not just about the project activities. The impact	Project impacts on MNES have been assessed in accordance with the MNES Significant Impact Guidelines (DoE 2013a). The location, type of dredge and method of placement and planned mitigation measures are entirely relevant to assessing the level of environmental impact of the Project. A full life cycle assessment was not within the scope of the draft EIS. However, it is noted that impacts of related 'upstream' projects are discussed in Volume 2, Section 6.2 of the draft EIS.

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38 cont.		needs to be assessed in relation to the significance to the environment irrespective of how much worse this could be if the Project were done badly. The question is one of acceptability against thresholds of residual impacts on the environment the only outcome appropriately considered. A full lifecycle analysis should also be included.	
		22. *"Sampling across a range of sites across a range of time periods is required to adequately characterise background water quality conditions (DERM 2009), and the drivers leading to changes in water quality conditions. This is critical to establishing local water quality objectives for the wetland prior to industry and infrastructure development occurring in the Abbot Point State Development Area."* Heavy metals may be a significant issue (pH is alkaline to variable but not acid). Does this statement mean that the development approval is recommended to be conditional on the completion of a fixed period (years) of sampling? If the sampling indicates there are potential significant problems does this provide grounds to reject the development application?	The quoted text is taken from Section 3.2.3 of the water quality assessment (Volume 3, Appendix O). At present, there are no defined Water Quality Objectives (WQOs) under Queensland State legislation (Schedule 1 of the Environmental Protection Policy for Water) for the Caley Valley Wetlands. In lieu of such data, the *Queensland Water Quality Guidelines* state that relevant default guideline values can be adopted. This approach has been taken in the draft EIS. Existing data demonstrates that background concentrations of some trace metals can exceed guideline values, varying in time and space mostly in response to catchment hydrology and tidal flushing. The impact assessment report findings are not conditional/sensitive to an improved understanding of background patterns and processes in water quality (including trace metals). As outlined in the impact assessment report, the Project is unlikely to alter physio-chemical properties of the receiving environments to the extent where metals present a significant issue. Water Quality Objectives are an agreed set of targets that are used

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38 cont.			as indicators of management performance. The Objectives are long-term goals for consideration in the management of waterways/wetlands, and are not intended to be used as regulatory criteria, limits or conditions. The report notes that collection of additional baseline water quality is required to allow establishment of local guidelines (and ultimately Water Quality Objectives) for the Caley Valley Wetlands and its drainages. The decision to progress the establishment of Water Quality Objectives for the Caley Valley Wetlands lies with the Queensland Regulator.
		23. There will be a requirement for maintenance dredging during operational life of the port. I was unable to locate any estimation of the requirements for this dredging or provision for how this would need to be managed. It is not adequate to assume this is a separate issue, insignificant, will involve similar controls, or that it will be land based. If maintenance dredging is an inevitable consequence of the development then it needs to be quantified and controlled as part of the development conditions.	The existing berth pocket at T1 has only required two minor periods of maintenance dredging since its development. The first maintenance campaign occurred in 1986 and the second in 2008 when it was combined with the capital dredging for berth 2. This demonstrates that little transport and deposition of fine grained material into dredged areas has occurred at the port since initial port construction and supports the conclusion of CDM Smith (2013b) that maintenance dredging is not likely to be required (for the areas to be dredged as part of the Project) for up to 20 years, given the naturally deep characteristics of the Port. Should the requirement for maintenance dredging arise, the relevant approvals would be sought as necessary at that time.
		24. The EIS should present the views of Traditional Owners, not just report that they have been consulted and that	Aboriginal cultural heritage within the project area has been managed under the cultural heritage management procedures in the

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38 cont.		discussions are ongoing. Have their concerns been addressed? General public may wish to express solidarity with their position and this is not possible if information is withheld or unavailable at this stage of the process.	Abbot Point ILUA. The Aboriginal cultural heritage surveys and agreed mitigation measures with the Juru People to avoid or minimise harm to Aboriginal cultural heritage in undertaking the Project are confidential under the terms of the Abbot Point ILUA. It is not possible to publicly release this information.
		25. I see no evidence that potentially negative effects on the tourism industry and local lifestyle choices been factored in. The social and economic analysis needs to go beyond just housing issues.	Appendix R (Volume 3) of the draft EIS contains the Social Impact Assessment technical report for the Project. Section 6.3.2 discusses potential impacts on 'community values and lifestyle' and includes a separate sub-section (Section 6.3.2.2) which specifically deals with potential impacts on the tourism industry.
		26. I did not find any reasonable consideration given to the impacts of the return of waters to the ocean or the water quality release criteria to be used for dewatering (rates, concentrations and loads). Screening and settling is not likely to remove the finest sediment particles (>16µm) which are known to be of most detrimental impact to the Reef and marine environment.	Refer to response provided for comment 4 of submission 38 (38.4 of this table) and Section 4.1.2.1
		27. The individual approval of a series of related projects is not a cumulative impact assessment and does not exclude the need for a cumulative impact assessment. The logic is flawed. Each individual EIS could claim the same thing as this one does without any EIS considering the impact of others. The criteria for the cumulative assessment of	Refer to Section 4.1.2.11

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38 cont.		specific environmental impacts are not clearly articulated and the issue is not comprehensively dealt with.	
		28. A long list of 'low' or 'low and medium' impacts 'cumulatively' should not necessarily be given a low outcome. That is the point of a cumulative assessment. The logic is flawed to suggest this. Reduced impacts per unit of shipping are relevant. However, this does not necessarily mean the impacts are low. The scale of development and operation is large. The port may accommodate multiple daily movements of several large ships daily for 50 years (if used as designed). If arguments are to be used based on unit impacts, full disclosure of the potential number of units involved is needed.	Refer to Section 4.1.2.11
		29. In my view offset should be time equivalent and like for like (seagrass loss for sediment reduction). If a cyclone were to damage a town and cut off food supply, would we consider it appropriate provide relief to a neighbouring town in ten years' time? The offset provisions here are the ecological equivalent of this human scenario but for the listed turtle and Dugong species involved.	The amount of seagrass permanently impacted by the Project represents <0.04% of the available seagrass habitat in the Abbot Point region. Please refer to Section 4.1.2.3 for further detail. However, this comment highlights an area which is appropriate to be clarified in finalising the EIS. . The life history or 'ecology' of turtles and Dugongs means they are not confined to a specific area (or 'town') and may travel between food resources or nesting sites across hundreds or even thousands of kilometres. Using Dugongs as an example - improving the water

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38 cont.			quality in areas of high conservation value outside of the local region such as the DPAs to the south (Edgecombe Bay) and north of Abbot Point (Upstart Bay) will help the dugongs that pass through the Abbot Point area and that utilise these protected areas (and where they spend most of their time) grow, reproduce and flourish. This improvement may involve limiting the erosion in catchments of the Burdekin or Proserpine River to reduce the amount of sediment entering the nearshore waters directly adjacent to these protected areas. This will in turn improve the chances of the seagrass meadows of Cape Upstart Bay and Edgecombe Bay surviving small or large flood events and continue to grow, reproduce and flourish. Ultimately the aim is to build in a resilience of the seagrass community in these highly productive conservation areas to natural or man-made changes in water quality. This will take time to achieve, but is worthwhile and will ultimately benefit the 'town' where the impacts have occurred.
		30. The seagrass in the impact area is considered to be 'sparse' in the assessment. This may represent a cumulative impact from existing operations and expansion may be a tipping point for suitability of the area as a whole for the regeneration of seagrass. A sparse seagrass may still be critical for the survival of species which move from one area to another to forage. It is the suitability of the site for seagrass growth that needs protection not the ambient status or standing crop of the	Refer to Section 4.1.2.3

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38 cont.		meadow.	
39	*Member of the public*	1. The dredge spoil will be dumped in disposal ponds which will obliterate part of the internationally significant Caley Valley. Wetlands. The document acknowledges that this will *"result in significant residual impacts to migratory birds and the Australian Painted Snipe due to direct loss of foraging habitat in the wetlands and disturbance to additional habitat from construction and operation activities."* There is no mention of any effort to replace destroyed areas by creating suitable artificial habitat.	Refer to Section 4.1.1.3 There is no proposal to place dredged material within the Caley Valley Wetlands as part of this Project.
		2. The ponds have unlined bases, and are at risk of overflowing into the wetland during heavy rains and cyclones. Any water that leaks into the wetland from the disposal ponds is likely to be high in sediment and nutrients, or even acid sulphate chemicals, which have the potential to destroy considerable areas of the wetland.	The impacts of sediment in return water to the receiving marine environment have been assessed in detail in the draft EIS. This information is now a matter for consideration by the Minister. Refer to Section 4.1.1.3
		3. Water flowing back to the sea from the dewatering ponds is highly likely to contain sediment, particularly during cyclones.	The impacts of return water to the marine environment have been discussed in detail within the draft EIS. A final Dredging Management Plan will be developed and implemented to manage potential impacts associated with sediment in the return water. Refer to Section 4.1.1.3

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39 cont.		4. Although the dredging will be done using a CSD, it will still generate large amounts of silt that will settle on and destroy seagrass habitats well away from the dredged area. It will also create a significant amount of muddy sediment that will spread to nearby coral reefs and the wildlife they support. The effect of sediment on coral is well known, from death of the coral plops to invasion by crown-of-thorns starfish.	Refer to Section 4.1.2.1
		5. Expanding Abbot Point will mean hundreds of extra coal ships traveling through the Reef, greatly increasing the chance of accidents.	Refer to Section 4.1.2.12
		6. The impact assessment acknowledges that the waters around Abbot Point are home to sea turtles, Dugongs, Snubfin Dolphins and migrating Humpback Whales. Many of these lifeforms are already endangered due to previous human activity. There are no proposals to avert the risk to these animals.	Refer to Section 4.1.2.5and to the management and mitigation measures in the Outline Dredging management Plan (Volume 3, Appendix W)
40	*Member of the public*	1. The cumulative effects of mine development and the provision of supporting infrastructure for transport and export of coal at the Abbot Point coal facility have not been assessed in any thorough overarching EIS. In particular, this Project's EIS has been produced on an individual basis without taking into full account the cumulative effects of the other planned projects to the regions flora, fauna, aquifers,	Refer to Section 4.1.2.11

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40 cont.		marine water quality and marine organisms. Section 4.5 on consequential and cumulative impacts ran to a total of two pages and appears to have been a desktop exercise with little or no scientific/ environmental engineering rigour. Many cumulative threats were discounted as low risk without any supporting evidence and indeed without taking into account the environmental records of the likely owners/operators of the bulk coal carriers loading at this port and transiting through GBRWHA boundaries.	
		2. The EIS for T0 implies the placement of dredge spoil on land adjacent to the existing T1 stockpile. This land has been identified for future T2 and T3 coal stockpiles as shown in Figure 3. Where will the T0 dredge spoil be relocated?	The Project is proposed to deliver the dredging requirements of the Abbot Point T0 project. The location of the DMCP is within the area previously designated for the Abbot Point T2 development. In the longer–term as described in Volume 2, Section 2 of the draft EIS. Further detail is provided in the project description in Volume 2, Section 2.
		3. Figure 3 shows that future terminals will end up surrounding the Caley Valley Wetlands. The impact of coal dust, ground water extraction and treatment, vehicle exhaust particulate matter, airborne soil/dust and 24/7 noise on the wetland has not been adequately considered.	Consequential impacts of the T0 terminal have been addressed in Section 6.2 of the draft EIS (Volume 2). In addition, Section 6.3.4 assesses the cumulative impacts of the Project and other projects at Abbot Point which have the potential to cumulatively impact on the wetland's ecological values.
41	*Member of the public* Note that	1. The GBR is worth trillions of dollars to the Australian economy each year as long as we keep it protected and in great health. It will earn Australia far more money than any	The Proponent has prepared a draft EIS in response to the DoE's EIS Guidelines (Appendix A of Volume 3). The economic merits or otherwise of the Project will now be considered by the Minister.

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	attachment to this submission was blank	mining.	
42	*Member of the public*	1. The map of the closest coral reef is incorrect in its assumption that Camp Island is the closest coral reef. (Submission lists the coordinates of a number of other coral reefs in proximity to the development).	Refer to Section 4.1.2.2
		2. The sediment retention dam (containment area) is designed to leak. The proposed design is that the bottom of the containment area (no hydraulic seal or floor liner) will drain through the soil profile due to the location of the containment area. The area will drain into the wetland and it appears designed to do so. The soil report also indicates that due to the soil profiles (horizons) the contaminated water will enter the water table. The outcome will be a continuous leaching of the containment area for many years into the wetland. This will be ether hyper saline water or extremely alkaline leachates from the treated PASS.	Refer to Section 4.1.1.3
		3. The dredge spoil is only the tip of the iceberg. Depending on the final locations of the other 5 stages, the final estimate of total dredge spoil is in the order of 18Mm^3 to 28Mm^3. Dumping this material on the land was always going to be the outcome for the simple reason that there is	The Project provides for the dredging requirements (1.1 Mm^3 *in situ* volume) of the Abbot Point T0 project and does not seek approval for dredging beyond this.

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42 cont.		no land sufficiently close to port to stockpile the coal and deliver the product economically to the ship loaders.	
		4. It is my belief that the Abbot Point expansion will threaten the GBR and local tourist industry due to: suspended silt pollution caused by heavy shipping at the port; ongoing damage caused by anchoring of heavy vessels; and oil and other residue pollution caused by heavy shipping.	Refer to Section 4.1.2.12 and Section 4.1.2.13
		5. The submission raises concern around the impacts of increased shipping associated with port expansion, specifically generation of suspended silt due to ship loading, berthing and turning within the port, transit through the Great Barrier reef stirring up the marine bottom and damage due to anchorage, as well as the oil and other residue pollution into the GBR caused by heavy shipping. The submission sates that these matters are not adequately addressed in the Project EMP.	Refer to Section 4.1.2.12 Increased shipping directly associated with the Project is expected to be minimal. However, it is acknowledged that the associated T0 project will result in increased shipping. Section 6.3.3.6 of the draft EIS (Volume 2) on consequential and cumulative impacts assesses a number of impacts associated with increased shipping. However, these activities are beyond the scope of the Project and its EMP.
43	Department of Environment *Australian Government*	1. The EIS states that the construction of the proposed DMCP does not include floor lining and includes modelled maximum 10ML/day vertical groundwater seepage for dry climate scenario. Please provide further discussion in relation to management measures that will be implemented to ensure any seepage into groundwater that may occur will not impact on the water quality of the adjacent GBRWHA	Refer to Section 4.1.1.3. It should be noted that preliminary and outline management plans included within the EIS will be further developed and finalised prior to the commencement of construction.

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. The full wording of submissions is not used for the purposes of brevity and readability.	Response
43 cont.		and on habitat for listed migratory shorebirds.	
		2. The Proponent identified that a 'dam-break' scenario would likely lead to a significant impact on areas adjacent to the project area due to scour from the release of sediments. Please provide further discussion on best practice design and management measures that will be implemented to minimise the potential for a dam-break scenario which could impact water quality of the adjacent GBRWHA and on habitat for listed migratory shorebirds.	Refer to Appendix E for a description of the engineering design risk analysis process that was undertaken for the Project.
		3. Please provide further details of the proposed groundwater management plan and monitoring program to assist in understanding whether the measures proposed to be implemented will be adequate to protect the water quality of the adjacent GBRWHA with seepage into groundwater systems and leakage from DMCP associated with extreme weather events.	A detailed groundwater monitoring plan will be developed prior to the commencement of construction. It is anticipated that project approval would be conditioned on this basis.
		4. Request further details of the proposed offsets net benefit fund, the delivery mechanism and timeframes for delivery. This will assist the Department in determining the adequacy of the fund to ameliorate the potential impacts to water quality and other attributes of Outstanding Universal Value as a result of input of sediments into the GBWHA and the loss of seagrass in the project area.	Refer to Section 5.2

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. The full wording of submissions is not used for the purposes of brevity and readability.	Response
43 cont.		5. The EIS states that further studies are required to understand the importance of the area to the Indo-Pacific Humpback Dolphin and the Australian Snubfin Dolphin. The EIS concludes that the proposed project will not have a significant impact on these dolphin species on a local or GBRWHA scale due to the short-term nature of the dredging for the Project and the application of mitigation measures, including visual monitoring for marine fauna in the immediate vicinity of the dredge. In the absence of further survey, please provide additional information to support the conclusion that the proposed project will not have a significant impact on these species, including an assessment of the expected or predicted effectiveness of mitigation measures, proposed monitoring and reporting, and the outcomes these measures will achieve.	Refer to Section 4.1.2.5 Detailed mitigation and monitoring measures will be outlined in the final Dredging Management Plan which will be developed prior to the commencement of dredging. Refer Section 4.1.1.6
		6. The listed migratory Latham's Snipe and the endangered Australian Painted Snipe are modelled within the exceedance area for dust and noise impacts of the project development adjacent to the Caley Valley Wetlands and may also be impacted by lighting associated with construction activities in the project area. Both species are particularly sensitive to disturbance. Migratory shorebirds are also one of the attributes of Outstanding Universal Value for the GBRWHA. Please provide further evidence	Refer to Section 4.1.2.8

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. The full wording of submissions is not used for the purposes of brevity and readability.	Response
43 cont.		that monitoring and management measures in the Outline Environment Management Plan will be sufficient to minimise impacts on these species, including an assessment of the expected or predicted effectiveness of mitigation measures and the outcomes these measures will achieve. Ideally, consideration should be given to scheduling construction activities outside of the summer months when listed threatened and migratory shorebird presence in the adjacent areas is at its peak. Note, the Australian Painted Snipe is no longer listed as a migratory species.	
		7. Vulnerability assessments produced by the GBRMPA find the risks associated with port developments range from low for the Humpback Whale to high for the Dugong and inshore dolphins. Dugongs were found to be at high risk within port limits and low risk outside, while marine turtles were at moderate risk from port developments. The port is located between two Dugong Protection Areas (DPAs) and may provide an opportunistic feeding area for animals travelling between them. Please provide further discussion on management measures that will be implemented to avoid and mitigate impacts to these species and how these actions are in line with GBRMPA vulnerability assessments.	Please refer to the discussion on seagrass in the T0 dredging area in Section 4.1.2.3. It is very unlikely that Dugong would target this area as an opportunistic feeding area, given that for the majority of the time there is no seagrass growing in this deeper water. Rather, there is seagrass growing closer inshore in shallower water away from the port operations and dredging area which during all previous monitoring surveys is found to exist (sparsely) from year–to-year and in some cases between seasons. Dugongs would utilise these nearshore areas opportunistically, which are located at a considerable distance from the dredging activities (and ongoing port activities).

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. The full wording of submissions is not used for the purposes of brevity and readability.	Response
43 cont.		8. In 2013 NQBP published a CIA for Abbot Point. This assessment finds that while there are unlikely to be residual significant impacts for marine fauna species, resulting from the development of the port, there is a need for ongoing monitoring to ensure management is effective and the port area continues to provide habitat. Please provide additional discussion on the management measures proposed to be implemented to manage potential cumulative impacts from current and proposed developments at Abbot Point, including barriers to movement for species, such as the Dugong, who will travel through the port, between the two DPAs.	In relation to cumulative impacts, it needs to be noted that temporal confines limit the occurrence of cumulative impacts of the Project in association with other development proposed at the port. Relevant to the matter of marine species, the cumulative impact assessment undertaken for the draft EIS (Volume 2, Section 6.3) identifies that the Project may impact cumulatively with: ▪ Increased shipping ▪ Impacts of dredging for proposed T3 in relation to permanent loss of seagrass habitat. The draft EIS stated that: "*with a high level of confidence it is considered that the cumulative impacts of shipping, including on the OUV of the GBRWHA, have been comprehensively addressed and are being acted upon by the Australian and Queensland Governments and industry bodies*". As noted in Section 4.1.2.12, the EPBC Act approval for the T0 project includes a requirement for the development of a *Marine and Shipping Management Plan*, for the construction and operational phases of the Project. The approval also includes offset requirements in relation to offsetting residual impacts to the marine environment, including shipping-related impacts. Mitigation measures for project impacts are addressed in Section 4.1.2.3 and Section 4.1.2.5 of this report.

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. The full wording of submissions is not used for the purposes of brevity and readability.	Response
43 cont.		9. The Proponent has proposed using a buffer area to protect habitat for listed threatened and migratory bird species from light, noise and dust impacts. This buffer varies in width but will be a minimum of 50m. Please provide a map that clearly identifies the buffer and indicates its width in areas adjacent to habitat for listed threatened and migratory species.	Refer to Section 4.1.2.9
		10. The proposed minimum buffer of 50m is much less than that outlined in the draft migratory bird guidelines (165m to 255m) and other sources, for example Borgmann *et al.* (2012). Most research that identifies appropriate buffers to mitigate for disturbance is based on mitigating impacts from human approaches, not industrial activities. The area where the buffer appears to be the smallest (50m) is adjacent to habitat used by a number of bird species, including the endangered Australian Painted Snipe. Please provide evidence to support the reasoning for the proposed buffer and discussion as to how the proposed buffer meets standards identified in the documents listed above.	Refer to Section 4.1.2.9
		11. Modelling of dust impacts indicates that a relatively large area of habitat for species using habitat adjacent to the project area will be affected by dust. The draft EIS	Refer to Section 4.1.2.8

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. **The full wording of submissions is not used for the purposes of brevity and readability.**	Response
43 cont.		concludes "*there is a moderate to low degree of certainty relating to the assessment of impacts of dust on shorebirds*". While the length of time that construction of the ponds will be relatively short, it is unclear how long they will generate dust following this phase. Given the uncertainty around the impacts of dust on migratory birds and their habitat adjacent to the project area, please provide details of a robust monitoring program to validate dust modelling and how mitigation measures will be modified if needed.	
		12. The EIS states that the DMCP have been designed to achieve a TSS concentration of 100mg/L in the return water discharge. However, it is not clear in any of the EIS documents where the 100mg/L TSS criteria came from or whether or not it has been accepted by Queensland's environmental regulator. The Queensland Water Quality Guideline for TSS in the Central Coast region coastal water is 2mg/L and should be compared with mean values rather than median values which are generally presented in the EIS. In addition, the Queensland Water Quality Guidelines state that for high ecological/conservation value ecosystems, such as the GBRWHA, there should be no change to the natural values of physico-chemical characteristics such as turbidity or total suspended solids as the result of discharge. Please provide justification for proposed levels of TSS in return water discharge, including	The mean value of turbidity across all monitoring sites at Abbot point measured between February 2013 to July 2014 ranges between 5.1 Nephelometric Turbidity Units (NTU) in the dry season to 6.9NTU in the wet season. This converts to TSS concentrations of 7.4mg/L in the dry season and 10mg/L in the wet season. These baseline site-specific values will be higher in inshore waters in the vicinity of the discharge point. The 100mg/L discharge concentration will be diluted by 1:40 with 10m to 50m of the discharge point to below 2.5mg/L, which is well below the background and may be indistinguishable from background. The discharge point is hundreds of meters away from the nearest sensitive receptor (seagrass). The open coastal central region *Queensland Water Quality Guideline* mean value of 2mg/L (adopted from GBRMP Water Quality Guidelines 2010) is a broad guideline, averaged across many open coastal areas in the central section of the GBR and is based on biotic responses to elevated TSS concentrations of macroalgae,

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. The full wording of submissions is not used for the purposes of brevity and readability.	Response
43 cont.		reference to relevant supporting guidelines and policies.	coral, and soft coral colonies. None of these receptors are found near the discharge point, which is an open sandy substrate. Given the more site-specific data available for Abbot Point waters, and the dilution factor in the close vicinity of the discharge, the higher worst-case discharge TSS concentration of 100mg/L is deemed to have no impact on the local sensitive receptors, and is also achievable from an engineering perspective.
		13. The EIS provides a particle size distribution for the sediments to be dredged but it is unclear whether or not the modelled impacts of the return of water are based on water containing only silt and clay particles (<16um). Given that these small sediments will be the slowest to settle, please clarify whether or not the modelled impacts of the return of water are based on water containing only silt and clay particles (<16um) and the monitoring and mitigation measures proposed to manage impacts to water quality in the adjacent GBRWHA.	The Numerical Modelling Report (Volume 3, Appendix N – Section 4.1) has specific details of the sensitivity testing and associated modelling undertaken on a range of discharge characteristics. The discussion highlights the differences and similarities in the size and concentration of the plume when different discharge depths, sediment particle sized and TSS discharge concentrations are taken into account. The sensitivity testing undertaken has shown the following key results about the plume resulting from suspended sediment released at the return water discharge: ▪ The TSS concentrations tested over the week long period are generally low, with concentrations of less than 1mg/L for most areas except directly adjacent to the discharge location. ▪ When the discharge is located in deeper water, the very low concentration plume extent is reduced compared to when it is in shallower water. This is a result of higher current speeds that

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. The full wording of submissions is not used for the purposes of brevity and readability.	Response
43 cont.			occur closer to shore at the Abbot Point headland, dispersing the sediment further. ▪ The low concentration plume extent reduces significantly as the concentration in the return water discharge is reduced. ▪ TSS concentration and daily deposition rate impacts with a mixed sediment composition in the discharge water are larger than with only clay sized sediment. Based on the results, it is suggested that a discharge location of 4m below Lowest Astronomical Tide (LAT) is preferable as it reduces the risk of the fine-grained material discharged being transported to the shore. The 4m below LAT discharge location has been adopted for the stochastic modelling undertaken as part of this assessment. As expected, the sensitivity tests have demonstrated that the plume extent varies significantly depending on the return water discharge TSS, with a significant difference in the very low concentration plume extent from return water discharge TSS of 100mg/L and 60mg/L. However, as the TSS is so low, it is not expected to result in any significant impacts or result in a large plume extending a long way from the discharge location. As such, the highest TSS tested of 100 mg/L was adopted for the stochastic modelling undertaken as part of this assessment. Adopting this TSS for the entire dredging period is considered highly conservative, as such a concentration would only be expected to occur towards the end of the DMCP filling. Based on the results of

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. **The full wording of submissions is not used for the purposes of brevity and readability.**	Response
43 cont.			the return water discharge sediment composition sensitivity testing, the mixed sediment composition has been adopted for the modelling. This is considered the worst-case as it results in more significant potential impacts in terms of TSS concentration and sedimentation compared to only clay being included in the return water discharge.
		14. In the Dredging Operations Plan the Proponent states that TSS is a time consuming measurement to make and can be correlated with turbidity which is much simpler and faster to measure. In order to correlate the TSS and turbidity of the return water, the Proponent proposes to measure TSS and turbidity four times a day over days three, five and seven of the first week of discharging. The proposed method could result in discharging water with TSS over the proposed 100mg/L limit for as long as it takes to get the report on the analysis for the first four samples, at least three days. At a minimum four samples of settled water at, or equivalent to, the discharge should be analysed each day until the TSS is below the accepted limits prior to any discharge taking place. Once the TSS discharge limit has been met in the settled water, then at least four additional samples over a period of at least four hours must meet the discharge limit before discharge occurs and these values should be used in the development of the TSS to turbidity ratio for future monitoring. The measures proposed in the Dredge	The actual measured background TSS at Abbot Point in waters offshore from the discharge point is a median of 3.6mg/L (3mg/L in the dry season and 3.6mg/L in the wet season). Nearer to shore in shallower water, the background value of TSS is likely to be higher. It should be noted that due to the dilution factor at the discharge point, the TSS in the water column within 10m to 50m of the discharge point is 1:40. The 100mg/L concentration will be reduced to just above the non site-specific Queensland Water Quality Guideline's mean value of 2mg/L and well below the measured actual background TSS concentration typical of site-specific marine water at Abbot Point. Initially the established relationship between TSS and turbidity (TSS = turbidity value x 1.45) outlined in the Marine Ecology Report (and Volume 2 of the draft EIS – refer Section 3.1.6.2) could be used prior to the establishment of a specific TSS/turbidity relationship at the weir box. Please note that a discussion on the mean background TSS and turbidity (as opposed to median TSS and turbidity) from 18 months

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. **The full wording of submissions is not used for the purposes of brevity and readability.**	Response
43 cont.		Operations Plan should be based on best practice and are sufficient to ensure that an adequate number of samples of settled water at, or equivalent to, the discharge are analysed each day until the TSS is blow the accepted limits prior to any discharge taking place. The Proponent states that the stability of the TSS to turbidity ratio would then be confirmed once a week. Given the relatively short period of dredging (5 to13 weeks) and the likelihood of different sediments producing different ratios, confirming the TSS to turbidity ratio weekly is inadequate.	of continuous logging is included in the response to submission 43 (comment 12).
		15. The Proponent states that once the TSS to turbidity ratio is determined, turbidity will be measured daily to ensure the discharges meet regulatory requirements. Given that turbidity can be measured in real-time, daily measurements seem inadequate to ensure that discharges stay within appropriate limits. A more appropriate method would be to use a suitable turbidity sensor and data logger with capacity to collect and average turbidity data over set time periods. Typically, in the water industry, turbidity data is collected every 15 seconds and averaged over 15 minutes, with a daily mean or median calculated if required. Please ensure that industry best practice methods are used to allow for a time based discharge limit to be applied. For example, the discharge should not exceed the turbidity equivalent of 100mg/L TSS in any rolling four hour period. Use a real-	The final Dredging Management Plan developed for the Project will outline monitoring requirements to ensure TSS/turbidity meets regulatory requirements. The Plan proposes application of a combined TSS (turbidity)/light-based trigger. The Proponent is prepared to consider monitoring of performance (e.g. at the DMCP outlet) against the turbidity trigger on a continuous rolling average basis. The Proponent considers a seven day rolling average period as appropriate given the nature of seagrass response to light levels. A seven day rolling average for turbidity is appropriate because it takes into account the fluctuations that occur in the light reaching the seafloor from changes in turbidity. The changes in light climate can alternate between full light (low turbidity) and no light (high turbidity) over a very short time frame (hours/days). This metric provides an overall picture of the light regime over a seven day

Ref.	Submission From	Summary of Submission *Note: The wording used in this column presents a summary of and extracts from submissions*. The full wording of submissions is not used for the purposes of brevity and readability.	Response
43 cont.		time data collection and time-based limit to ensure that the TSS/turbidity limit is applied consistently for the entire dredging operation to ensure that the daily TSS collection met the 100mg/L limit.	period, which corresponds to the light requirements of nearshore seagrasses.
		16. The Proponent states that pH and dissolved oxygen (DO) concentrations would be measured daily in the return water discharge. Real-time analysis for these parameters is readily available and should be utilised appropriately to ensure adequate notification of adverse acidic events as well as informing adaptive management, rehabilitation and/or recovery efforts.	The Proponent is prepared to carry out real-time analysis of pH and DO.

Appendix B

Campaign Submissions

Advisian
WorleyParsons Group

Queensland Government

Campaign 1 – Sum of Us

Letter sample:

The Draft Environmental Impact Statement for the Abbot Point expansion plan concerns me because the Project will irreversibly ruin our Great Barrier Reef. Reef seabed in World Heritage waters will be ripped up, and dredging will occur very close to the homes of endangered species. Please stop the expansion of Abbot Point.

Campaign 2 – Fight for the Reef

Letter sample:

Dear Director-General of the Queensland Government Department of State Development,

The Draft Environmental Impact Statement for Abbot Point, including dredging and land dumping plan raises some serious concerns for the Great Barrier Reef and nearby wetlands as outlined below.

- *1 million m3 (approx. 2 million tonnes) of dredging inside the Reef World Heritage Area (WHA) which will damage seagrass habitat that dugongs and turtles rely on for food and create large muddy plumes that could spread for many kilometres.*
- *Increased shipping associated with the expansion will increase risk of accidents and threaten marine ecosystems, particularly whales and their calves that are migrate through this area*
- *The dredge spoil will be held in storage ponds covering an area of 80ha and located just 50m from the Caley Valley Wetlands. The walls of the ponds will be lined, but the base of the ponds will be unlined*
- *Wastewater from the disposal of dredge spoil will be discharged into the ocean and stormwater from the ponds into the wetlands; It's not known what contaminants this water could contain, but it is likely to be loaded with sediment and nutrients.*
- *The dredge spoil disposal ponds will be on a low-lying coastal plain adjacent to the coast in a tropical area prone to cyclones. The risk of flooding and overflows during heavy wet season rains, storms or cyclones is high. Any overflow from the ponds will flow directly into the wetlands.*
- *The seabed sediments in the area that will be dredged are known to contain Potential Acid Sulfate Soils that can become very acidic when exposed to air.*
- *The waters around Abbot Point where the dredging will take place are home to rare and endangered sea turtles, dugongs, snubfin dolphins and in the path of migrating humpback whales*
- *Currently, Abbot Point is running well below capacity and many major Australian and international banks have ruled out funding the mining projects upon which its expansion depends. There is a very real risk that if this project was to go ahead in the immediate future it could become a stranded asset that has caused significant environmental harm yet realises very little economic benefit.*

Campaign 3 – Greenpeace

Letter sample:

To the Abbott Government,

The Great Barrier Reef is a stunning natural wonder. It is the world's largest coral reef ecosystem and it is under threat. The Queensland Government wants to dredge millions of tonnes of seafloor from within the Great Barrier Reef World Heritage Area and dump the spoil right next to the Reef and near nationally significant wetlands.

The Abbot Point Growth Gateway Project (EPBC 2015/7467) will have unacceptable impacts on the outstanding universal values of the Great Barrier Reef: I'm calling on you to exercise your power and reject this proposal.

The science is clear: we can have the reef or coal, we cannot have both. I urge you to protect the reef and put an end to this proposal to dredge and dump at Abbot Point.

Campaign 4 – GetUp

Letter sample:

The Draft Environmental Impact Statement for the Abbot Point expansion plan raises some serious concerns…

Campaign 5 – AVAAZ

Letter sample:

To whom it may concern,

I'm opposed to the expansion of The Abbot Point port for the following reasons …

Campaign 6 – Mackay Conservation Group

Letter sample:

Dear Minister Lynham,

Thank you for the opportunity to comment on the draft EIS for the Abbot Point Port expansion (EPBC2015/7457). I feel that the EIS has failed to adequately address the following issues and impacts.

1. The Dredging Operation

The dredging operation will destroy important seagrass habitat which support many marine animals including rare and endangered dugong and sea turtles. Seagrass meadows also provide shelter for many important fish species.

The dredging operation will also create a muddy plume that could spread for many kilometres, potentially affecting the nearby coral reefs and seagrass meadows. There are a number of small but significant reef systems within 10 km of the dredge site as well as mackerel spawning grounds.

2. The Dredge Spoil

The dredge spoil will be dumped in storage ponds located within 50-100m of the internationally significant Caley Valley Wetlands, home to up to 40,000 waterbirds, including many rare and threatened species. The spoil contains potential acid sulfate soils that can become very acidic when exposed to air. The unlined ponds will allow up to 70 mega litres of contaminated water to seep into the groundwater, wetlands and ocean each week.

This is likely to affect salinity levels in the wetlands which will in turn affect the quality of the wetland ecosystems within this wetland aggregation.

Wastewater from the disposal of dredge spoil will be discharged into the ocean. Stormwater from the disposal ponds will be discharged into the wetlands. It's not known what contaminants this water could contain, but it will include fine sediments that do not settle out fully from the dredge spoil ponds and contaminants from shipping and other port operations for the decades the port has been in operation. For example construction company John Holland was fined for allowing shoddy containment operations by a sub-contractor engaged to sandblast the jetty at Abbot Point a few years ago. Tonnes of toxic second-hand garnet used for the sandblasting ended up dropping off the jetty and into the ocean. Contaminants from that episode are likely to be in the dredge spoil as it was never recovered.

The dredge spoil disposal ponds will be on a low-lying coastal plain adjacent to the coast in a tropical area prone to cyclones. The risk of flooding and overflows during heavy wet season rains, storms or cyclones is high. The existing wastewater ponds have failed in the past in flood events which were not major historical events. Any overflow from the ponds will flow directly into the wetlands.

The endangered Australian painted snipe has essential habitat within 50m of the proposed dredge spoil dumping site which puts it at risk from; wastewater pond failure, changes to groundwater hydrology and the noise and activity of the dumping project.

Changes in the salinity of Lake Caley from this proposal (see comments on the groundwater mounds) will probably also affect the numbers of freshwater bird species which can use these wetlands.

This project will facilitate more coal and more coal handling which will increase the coal dust pollution in the wetlands.

3. Shipping impacts on water quality

There are currently around 174 ship visits per annum to Abbot Pt. With the construction of T0, this is expected increase by 560 ships at full capacity. The increase in shipping activity will have a significant impact on the local marine environment.

The berthing activities of large ships cause massive plumes of silt. The suspended silt then spreads kilometres up and down the coast with the tides.

A ship underway will also cause silt pollution as the propeller re-suspends the silt from the shallow, coastal sea floor which is then carried north and south by the tides.

The anchoring of large ships with large anchors and large chains completely destroys any and all life on the seafloor. As well, the anchor and chain re-suspend the silt, creating significant silt plumes that will travel up and down the coast, harming nearby seagrass meadows and coral reefs. Such damage at Gladstone was up to 16km offshore.

An increase in shipping will bring an increase in the risk of groundings, oil spills and the introduction of alien species through bilge water. These large coal ships also burn heavy bunker diesel oil which is a source of carcinogenic diesel particulates, so sir pollution from this source will also rise.

These are downstream impacts from this dredge disposal project as they would not occur if the dredging for the port expansion did not take place. As such these impacts must be addressed.

The impacts expressed above are already occurring up and down the Great Barrier Reef coast. As well, they are cumulative impacts and should not be treated in isolation. The Great Barrier Reef is facing a death by 1000 cuts.

4. Justification

What also needs to be considered is the fact that the Abbot Point expansion is quite likely to be unnecessary. Currently, Abbot Point is running well below capacity. The need to expand Abbot Point is based on the assumption that the Galilee Basin coal mines will soon be in production and shipping out through Abbot Point. Given the current structural decline of the coal industry and the global movement away from coal for energy, the Galilee Basin is not an economical proposition and will not be opening any time soon.

Campaign 7 – North Queensland Conservation Council

Letter sample:

Dear Minister Hunt and Minister Lynham

Thank you for the opportunity to comment on the draft EIS for the Abbot Point coal port expansion (EPBC2015/7467). I am writing to express my deep concern that approval of this proposal would permanently damage the Reef and its inhabitants, put further pressure on threatened species and thousands of migrating birds that use the nationally listed Caley Valley Wetland, and exacerbate the greatest threat to the Reef and the planet – climate change.

The Great Barrier Reef is in a perilous state, exposed to many pressures. I acknowledge that the Federal and State governments are working to protect the Reef from these pressures. However, the expansion of the port at Abbot Point would worsen the problems, working against government efforts and wasting taxpayers' money .

Dredging of the seabed would destroy seagrass meadows that provide food for many marine animals, including rare and endangered dugong and sea turtles, and provide shelter for many fish species. The act of dredging creates mobile plumes of sediment. Around Abbot Point this would see significant reefs being smothered.

The dumping of the spoil from the dredging project in a spot squeezed between the Great Barrier Reef World Heritage Area and the nationally recognised Caley Valley Wetlands, on an exposed lowland, is asking for trouble, especially with the expected increase in intense weather events in the area.

The endangered Australian painted snipe has essential habitat within 50m of the proposed dredge spoil dumping site which puts it at risk from wastewater pond failure, changes to groundwater hydrology and the noise and activity of the dumping project. These risks would also apply to the 40,000 or so birds that frequent this area - one of the few coastal wetlands left in eastern Australia.

The expanded port would lead to vastly more ships in this fragile reef area, with the inevitable increase in ship-related incidents. In addition to the increase in damage due to normal practices such as berthing and anchoring, more ships means mpre risk of accidents. Within the last two months in the area, we have seen a whale calf killed by a ship's propeller and an oil spill involving oil contamination from Cape Upstart to north of Hinchinbrook Island.

Of huge importance is the fact that this expansion is to enable the export of coal. The burning of coal is the greatest contributor to climate change, which is the greatest threat to the Reef. As the world recognises the economic, social and environmental superiority of renewable energy, the market for coal is diminishing rapidly. To damage the Reef for a dying industry would be illogical.

To increase Australia's contribution to climate change while trying to protect the Reef makes no sense.
For the above reasons, I urge you to abandon plans to support an expansion at Abbot Point

Appendix C

Technical Responses to Selected Submissions

Advisian
WorleyParsons Group

Queensland Government

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AGE Response to groundwater assessment review included in submissions no. 2 and 5

[1]Ref No.	Issue and response
P7, 4.1	The T0 area is not shown in any of the maps.
	Response: Noted, however this is not considered material nor has it any relevance to the outcome of the study. This area is identified in the main EIS document.
P8, 4.1	Suggest differentiating permeability (k) and hydraulic conductivity (K), as per Barnett et al. (2012)
	Response: This is not considered material nor relevant to the outcome to the project and report.
P8, 4.2	Worth noting the rather long screen lengths that were used. McLean et al. (2011; Standards/Guidelines for Installation and Management of Test wells and Piezometers) recommends up to 2 m screen lengths for monitoring wells.
	Response: This is not considered material to the project and report. Bores were constructed in accordance with "Minimum Construction Requirements for Water Bores in Australia", (National Uniform Drillers Licensing Committee, 2012) as stated in paragraph 2, page 8. McLean et al. (2011) recommend bores be constructed with 2 m screen lengths only when the total depth of the bore is less than 3 m. For deeper bores, McLean et al. (2011) state "The length will depend on the purpose of the bore and which groundwater profile is being targeted" (Section 9).
P8, 4.2	It would be worthwhile including the borehole logs from DNRM wells and other wells drilled in the area.
	Response: This additional data is not considered necessary to include in the report. If required this information is available through Queensland Globe which can be downloaded from the Department of Natural Resources and Mining website.
P12-13, 4.5	For the purposes of getting a sense of the tidal phase, it may be useful to know the time of measurement for water levels in Table 4.4. Additionally, information on the tidal fluctuations at this site would be beneficial.
	Response: The response to tidal fluctuations is noted in Section 4.5, page 15. However, further consideration of tidal influences to the project are not relevant as the model used to predict impact from the project utilises weekly time-steps making it impossible to capture the sub-daily tidal variations that occur in the ocean. As such and for the purpose of this study, a mean sea level of 0 mAHD constant head boundary was adopted to represent the coastal fringe.

[1] Review was completed by Dr. Adrian Werner, Flinders University.

[1]Ref No.	Issue and response
P12-13, 4.5	There are negative water levels here. The only way this can occur is: (a) density effects within the well are corrupting the water levels, (b) pumping, (c) wetland water levels are below sea level, or (d) there are tidal effects whereby water levels are measured at low tide. The reason for the water levels at <0m AHD water levels should be identified. Additionally, mean sea level is often not exactly 0 m AHD, so this ought to be determined as well – i.e. the elevation of mean sea level in m AHD.
	Response: The water levels measured are actual levels measured in each monitoring bore. The negative (below "sea level") water levels are for those bores located either within or immediately adjacent to the wetland where elevations have been determined from the site LIDAR data. Reasons for the negative groundwater levels in those bores either adjacent or within the wetland are considered a function of "evaporative pumping" in this area, which is either close to or below sea level.
P14, 4.5	It is very difficult to discern the directions of groundwater flow from head values taken 6 months apart. Also, most of the arrows that meant to indicate flow direction are not incidental to the measurement points, but are shown in areas where there are few measurements. The directions of arrows to the north-west of the wetland are especially contentious. There is not enough evidence presented to defend some of the flow directions identified on the map, and therefore, it seems that some of these are guessed. They may well be correct, but there is not enough evidence presented in the report to support or disprove the flow direction interpretations.
	Response: The groundwater flow directions shown in Figure 4.2 represent overall inferred flow directions based on the observed groundwater levels measured in each bore at the time of the 2015 field studies (as stated in Section 4.5 and Table 4.4). It is noted that the potential for confusion in this regard, is possibly due to the reference to the bore construction date, which is not related to the groundwater measurements. Whilst the complexity of the salinity stratification complicates correcting these levels relative to the salinity densities measured in each bore, the purged salinity data does provide an opportunity to identify the magnitude of this change in nominalised fresh water levels. However, this shows minimal variation in these water levels such that there is no material change in the inferred groundwater flow directions shown in Figure 4.2.
P15, 4.5	Depths to groundwater are not especially meaningful – referring to these prior to a sentence about groundwater movement gives the impression that groundwater flow directions depend on the depths to groundwater, which is not the case. An improved discussion of the groundwater elevations is needed. There is not a coherent presentation of these that allows the reader to obtain a reasonable sense of the groundwater flow story for the site. There appears to be adequate groundwater points of measurement, and adequate access to surface water bodies, to obtain a detailed hydraulic depiction of groundwater flow, but this is not expressed in the report. It is particularly worrying that no surface water data are provided – this appears to be a significant oversight given their importance in interpreting groundwater flow directions. Also, a more in-depth discussion is needed aside from "groundwater movement is generally away from elevated topography". There is more going on here that this simple Tothian-type assertion, particularly given that water levels below 0 m AHD have been measured, and other somewhat peculiar head trends.

[1]Ref No.	Issue and response
	Response: Table 4.4 (section 4.5) details depth to water levels and groundwater elevations. Figure 4.2 presents groundwater elevations measured on 5 May 2015 (NQBP bores) and 20 May 2015 (AGE bores). Surface water has been addressed by BMT WBM Pty Ltd (BMT WBM) with interaction between BMT WBM and AGE undertaken where required. *The assumption that "groundwater movement is generally away from elevated topography" (where the dredge material containment pond is located) provides for a conservative approach for assessing impact on the wetlands. A conceptualisation of gradients from the pond to the wetland is considered to represent a conservative approach with respect to migration of saline seepage.*
P15, 4.5	The logger data showing tidal oscillations provides an opportunity to obtain aquifer hydraulic properties from the time lag and attenuation of the ocean's tidal signal (e.g. using the Ferris (1951) solution), albeit the muting effect of the wetland is not known.
	Response: This is noted in Section 4.5 (refer Submission P12-13, 4.5), and as such is not considered further given the limitations of the model and is not considered material nor has it any relevance to the outcome of the study.
P15, 4.5	I disagree that groundwater movement/discharge is principally toward the wetland. There appears to be flow towards the sea, although this may be caused by watertable overheight induced by tidal fluctuations. Without water levels from the wetland, and without knowing the groundwater heads at the shoreline, it's difficult to know. Wetland water levels (spatial and temporal variability) are critical to improve the hydrological interpretations being presented here.
	Response: The available water level data indicates a gradient towards the wetlands. As discussed above, this assumption represents a conservative approach with respect to predicting impact on the wetlands from the project. If there is an impact from a tidal overheight, then this will be local to the coastal dunes and will most likely provide greater opportunity for the principal groundwater movement to be towards the wetlands where groundwater level measurements are either close to or lower than mean sea level.
P16, 4.5	The high variability of Fig. 4.4 water levels highlight the importance of "snapshot-in-time" monitoring of water levels to make sense of flow directions. That is, it is not possible to interpret flow directions from water levels taken 6 months apart given the high seasonality shown in Fig. 4.4.
	Response: Figure 4.4 represents water levels measuring in May 2015 and not 6 months apart.
P16-17, 4.6.1	It's a little academic, but worth noting the National Groundwater Association (NGWA) refers to water up to 1000 mg/L as "Freshwater", and has other terms for the different water types (http://www.ngwa.org/media-center/briefs/documents/brackish_water_info_brief_2010.pdf). Brackish/moderately saline water is typically up to 10,000 mg/L according to the NGWA. I think lumping water of 500-1000 mg/L into a "brackish" water type will have the effect, at least in descriptive results, of covering up some of the occurrence of freshwater in this area.

[1]Ref No.	Issue and response
	Response: The report states that freshwater is classified as water having a salinity level less than 500 mg/L (or less than ~750 µS/cm). This is supported by the two references quoted in the report. The first reference is from the Food and Agricultural Organisation of the United Nations (2013). The second is an Australian reference from the National Water Commission. The submission's reference is from a North American based organisation. As acknowledged in the submission, this statement is academic. The references cited in the report are considered more relevant and material to the study.
P18, 4.6.1	I disagree that EC measurements range from 3,285 to 126,200, as suggested in the two dot points – there are clearly values <1000 µS/cm in Figure 4.5. It's also worth noting that the long well screens and the purging process result in an average salinity from what is a highly stratified groundwater system. Therefore, one must be extremely careful about interpreting the purged salinities, given that different parts of the aquifer will contribute different amounts of groundwater (of varying salinity) to the well during pumping. If high salinity water is in a high K layer that is intercepted by the well screen, the measurement from the purged well will show a high salinity regardless of whether there is low salinity water (in particular, in slightly lower permeability sediments) within the profile. Hence, the long screen wells may well have masked the occurrence of freshwater occurring near the watertable (floating above the higher salinity/more dense groundwater), at least in the samples from purged wells.
	Response: The water quality data summarised reflects that measured when sampling the bores and is representative of that water collected when sampled, and does not account for the stratification that has subsequently been identified through salinity profile measurements. The salinity stratification is discussed separately in the latter half of the Section4.6.1.
P18, 4.6.1	If the report adopted a salinity classification that follows the FAO (Food and Agriculture Organisation) and NGWA, it would be reporting that there is freshwater in the upper part of the groundwater profiles of the sampled wells.
	Response: The report states that freshwater is classified as water having a salinity level less than 500 mg/L (or less than ~750 µS/cm). On this basis it is acknowledged that freshwater was measured at only two locations MW04 and Site 6, as observed from the salinity profiling in the monitoring bores. However, the general trend indicates a brackish to saline groundwater overlying a hypersaline groundwater in the monitoring bores. This submission statement is therefore not considered material to the outcome of the study.
P18, 4.6.1	It may be possible to speculate on the lack of low-salinity water in the profile at sites GW03 and Site 3 – e.g. could it be caused by the movement of saline water towards the wetland from the north-east (depending on the nature of the dark-green patch in the aerial photograph of Fig. 4.2)?
	Response: An explanation for the lack of low-salinity water in the profile at sites GW03 and Site 3 is difficult to determine as they are outliers when compared against the salinity data for the other nearby monitoring bores
P23, 4.6.4	There is no evidence provided in the report to support the claim that activities at the Port have not impacted the water quality. Also, in evaluating the water chemistry results, a comparison between the ionic ratios of groundwater samples to seawater ionic ratios might provide some insights into processes and causal factors that lead to increased chemical concentrations.

[1]Ref No.	Issue and response
	Response: This statement is acknowledged, however the water quality data from the monitoring bores sampled for this EIS do indicate the major ions concentrations may be a result of evaporative concentration, and the elevated metals concentrations possibly a reflection of baseline groundwater quality for an igneous geology environment. Given the coal stockpiles comprise washed coal product, any residual salinity would be expected to be diluted by fresh rainfall. The resultant discharge as seepage to the underlying groundwater would therefore be expected to be brackish to saline and potentially less saline than that for the receiving environment. Hence, it is possible the elevated groundwater quality data masks impact from the Port activities.
P24, 5	"recharge rainfall" in the fourth paragraph should probably be "rainfall recharge". It is not reasonable that recharge is only occurring in the higher terrain, and recharging the bedrock and alluvial terrace deposits. Given the high summer rainfall, it is more likely that recharge occurs in a widespread manner across the system, with the exception of wetland areas that are already inundated. Also, the interpretation of discharge into the Coral Sea is not consistent with the flow to the wetlands that is suggested earlier in the report.
	Response: This statement is referenced from a previous study and is not considered material to the outcome of the study The conceptualisation presented in Figure 5.1 includes rainfall recharge across the entire area, as does the numerical model built from the conceptualisation.
P24, 5	There is mention of "flooding of the wetland", but to this point in the report, it is not clear the degree to which the wetland is flooded with freshwater during the wet season. Indeed, the hydrology of the wetland is hardly mentioned, but seems an important element of the study.
	Response: Surface water has been addressed by BMT WBM Pty Ltd (BMT WBM) with interaction between BMT WBM and AGE undertaken where required. This statement is not considered material to the outcome of the groundwater assessment.
P24, 5	It is not clear that the hyper-saline groundwater is trapped and stagnant, as reported here, although it is possible that this is the case. It may be the result of ongoing evapo-concentration. It may be important to decipher which is the case. Importantly, the behaviour of the wetland, in terms of freshwater inputs from surface water, and seawater inputs, should be explored to be able to comprehend the influence of the proposed development.
	Response: This statement acknowledges the uncertainty of this hypersaline environment as does this study. It is considered this statement is immaterial to the outcome of the study.
P24, 5	There is a statement that flow from the DMCP area is west and south, but this is based on a lack of information to the east and north. It ought to be recognised here that the direction of flow to the north and east of the wetland is presently unknown.
	Response: Whilst it is acknowledged that on a regional scale, there will be some groundwater movement towards the oceans, on a local scale groundwater movement is observed south and west from the DMCP towards the adjacent wetlands.

[1]Ref No.	Issue and response
P25, Fig. 5.1	This is a really useful diagram for gaining an appreciation of the conceptual model of the system. However, Fig. 5.1 would be improved if: (a) It showed the elevation of the wetland relative to the sea. This is critical to understanding its behaviour. That is, how is possible that negative groundwater levels occur? Perhaps the wetland bathymetry is below sea level. If this was the case, the wetland would probably be drawing seawater because the hydraulic gradient would be from the sea to the wetland, and then evaporation would account for the seawater discharge to the wetland. Without knowing the relative elevations, it is not clear how the system operates. The conceptual model doesn't reflect the earlier notion that "Groundwater movement is principally under gravity towards the coast with discharge generally into the Coral Sea", as mentioned earlier. (b) There is no evidence presented for salinities to the south of the wetland – I suspect that if there is mountain-block recharge, there may be fresh groundwater overlying saltier groundwater in that area, but data should be presented to understand the inland boundary conditions for the study area. (c) The notion that there is only brackish/saline water in the system is a little misleading. The salinity profiles have detected freshwater. Plus, the monitoring wells capture the salinity over only a small proportion (i.e. of the spatial area) of the system. I suspect that the aquifer contains freshwater in places. (d) The "groundwater saline interface" doesn't make sense to me. There is hypersaline water in the system, so the seawater interface is not going to hold the classic wedge shape that is drawn here. (e) The offshore groundwater discharge is drawn in a peculiar way – it ought to be discharging primarily at about the low-tide mark. It is drawn as though it is something of a surface flow. (f) The stratigraphy of the conceptual model has the alluvial sediments ending at the shoreline. I suspect that this is not the case. This gives the impression of a basement high that retains alluvial groundwater and restricts its discharge to the sea. If this is the case, it should be clearly stated and recognised in the report. I suspect that the alluvial sediments extend offshore, and are a pathway for submarine groundwater discharge. Whatever the case, it should be clarified because a basement ridge at the shoreline, similar to the one drawn here, would have major implications for groundwater discharge/inflow to/from the sea.

[1]Ref No.	Issue and response
	Response: The above suggestions are noted and in part may be correct though are not considered material. Specific points are addressed below: *(a) The conceptual model indicates groundwater movement towards the ocean with localised discharge into wetlands (as per the observed data).* *(b) Evidence for salinity south of the wetlands is unknown and is not considered relevant in relation to seepage from the DMCP.* *(c) The groundwater beneath the DMCP is principally brackish to saline water overlying hypersaline water. Fresh groundwater was only measured at only two locations MW04 and Site 6, as observed from the salinity profiling.* *(d) The "groundwater saline interface" is indicative only and further investigations would be required to quantify its presence and extent. The actual extent of this interface is not considered relevant given the presence of the hypersaline conditions observed beneath the DMCP and adjacent wetlands.* *(e) Comment acknowledged.* *(f) The presence of the basement high that retains alluvial groundwater and restricts its discharge to the sea in the conceptual model is based on observations by Connell Hatch (2009) and is stated in the report.* *In spite of the above responses, these comments are not considered material as these amendments would not alter the outcome of the study.*
P26, 6.3	If solute transport is being simulated, then it is also important to set the discretisation so that a grid-independent solution has been obtained. That is, the grid isn't designed simply to simulate the geology and obtain reasonable run-times, as suggested here. There is also a need to obtain a mathematically reliable solution. This ought to be mentioned (and tested), by adopting different mesh resolutions and re-running the model (referred to as a "grid-independence test").
	Response: The numerical stability of salinity transport was considered in the model design of spatial and temporal discretisation. However it was not discussed in the report. To ensure the numerical stability of mass transport solution, the grid and time step size was selected such that it was small enough to meet both Peclet number and Courant number criteria which are the two main criteria in mass transport modelling. This resulted in stable mass transport simulation as observed in the results.
P26, 6.3	From the description here about the model layers, it appears that the recently drilled wells were not considered. This seems like an oversight.
	Response: The recent bore logs were not used in the building the model layer as the data was only available after the model had already been built. However, the new bore logs confirmed that the current model structure and layers are appropriate.
P26, 6.3	The use of inactive cells ought to be illustrated.
	Response: The comment noted. However it is not considered material nor relevant to the outcome to the project and report. *The cells that covered the ocean in the model were switched to inactive. But this was not mentioned in the report.*
P27, 6.3	The model grid could have been coarsened in the western and southern areas, furthest from the area of interest, to save on computation effort.

[1]Ref No.	Issue and response
	Response: This is not considered material nor relevant to the outcome to the project and report. *The minimum cell size was selected small enough to comply with the mass transport numerical stability criteria. The refinement was extended to the west and south of the site to ensure appropriate numerical solution of the transport simulation where the change in concentration was expected to occur. Therefore the model grid in the western and southern areas could not have been coarsened.*
P28, 6.3	The layers are depicted as continuous sequences. It is perhaps more likely that layers are discontinuous and lenticular/sinuous (e.g. see top of P24). Vertical flows may be "patchy" rather than the diffuse upward flows that would occur through the continuous layer representation that seems to have been adopted.
	Response: It is noted and agreed that in some areas it is likely the layers are discontinuous or lenticular/sinuous but the available geological data supports the conceptualisation and necessary simplifying assumptions of continuous sequences.
P29, 6.3	Seems like a typo – i.e. 276 m of Layer 1.
	Response: The 276 m thickness is correct. The base of layer 1 is assumed to be relatively flat away from where data is available and the outcrop areas then result in larger layer thicknesses.
P29, 6.5.1	I suspect that the head value of 0 m AHD was not determined from mean sea level at Abbot Point, as suggested. It is unlikely that mean sea level is exactly 0 m AHD – it is usually slightly different. The mean sea level at Abbot Point should be given in terms of m AHD to support this assertion. Additionally, the tide will impose a head that exceeds that of mean sea level, referred to in the literature as tidal watertable overheight. Tidal watertable overheight can produce a significant amount of additional head at the shoreline (i.e. above mean sea level) that may modify significantly the interpretation of flow directions in coastal aquifers.
	Response: This is not considered material nor relevant to the outcome to the project and report *Using Queensland Government Coastal Data System database for Bowen from 1986 to 2014 and Queensland Tide Tables from Maritime Safety Queensland, showed a mean sea level of 1.75 m above LAT (-1.63 mAHD)which is equivalent to 0.12 mAHD. This 12 cm difference at the coast line is not expected to impact materially on the predictions and conclusions of the modelling. Tidal overheight may also exist as suggested, but this is likely to be a local affect constrained to the dunes. If it is present and impacts on the regional groundwater flow directions, then it supports the conceptualisation and model design we have targeted with water principally flowing to the wetland.*
P29 & 31, 6.5.1	The location of fixed head cells and the shoreline do not coincide in some places (e.g. in the west and southeast of Bald Hill). Why this was done requires some explanation.

[1]Ref No.	Issue and response
	Response: The comment noted. However it is not considered material nor relevant to the outcome to the project and report *The fixed boundary condition on the shoreline was adopted using the latest LIDAR available for Abbot Point. However the background map used in the figure predates the LIDAR data and the alignment should have been updated to be consistent with the LIDAR data (used to define the coastline).*
P29-31, 6.5	What sort of boundary condition was adopted for the southern, eastern and western limits of the model? This is not mentioned.
	Response: No flow boundary condition was applied to eastern, southern and western boundary of the model. The model extend was selected big enough that the impact from the pond would not reach the eastern and western boundary of the model.
P29, 6.5.2	Recharge is generally not discernible from calibrating the model to water levels, due to parameter non-uniqueness. It is well known that recharge estimation requires a combination of approaches. Also, more explanation is required for the approach to imparting recharge seasonality (was it linked to rainfall?) and how "high recharge" and "low recharge" zones were devised. What are the recharge rates?
	Response: Comment noted. The recharge rate could have been included in the report. *Recharge has been calibrated in the combined calibration with hydraulic conductivity which it is noted can result in non-uniqueness in the calibrated data. During the calibration the hydraulic conductivity was defined by the field data collected, and thus reduced the potential for non-uniqueness.* *The high and low recharge zones were based on the surface geology of the model area. For each recharge zone, a lower and upper bound for recharge rate was adopted in the calibration. The recharge rates calculated through the calibration, were used in the predictive simulations.* *For the steady state calibration, average annual rainfall and for the transient calibration (which captured the seasonality), daily rainfall data were used. The recharge calculated through calibration was the percentage of the rainfall entering the groundwater system.*
P29, 6.5.3	How was the river package parameterised? What heads were used when it was turned on? It seems from the report that there is very little information on surface features, so it is perhaps difficult to produce an accurate representation of water courses and the wetland. However, it would be useful to track the simulated discharge to watercourses and compare this to any available knowledge about the persistence/absence of base flow/groundwater discharge to watercourses. Water levels ought to have been obtained for the wetland to assist in understanding the wetland's behaviour, in particular, to assist with populating the Riv package.

[1]Ref No.	Issue and response
	Response: In the river package, four different types of river cells were used. Minor creeks, major creeks (Splitters Creek), surface drainage and wetland. *Each of these river types had its own depth, width and river bed thickness. The river bed conductance was one of the parameters obtained from the calibration of the model.* *All the minor creeks are dry and therefore were assigned zero river head. A river depth of 0.5 m was assigned to the main watercourses (Splitter Creek).* *The river cells in the wetland were switched off in the dry season when the wetland was dry and were switched on during wet season when the wetland was filled with rainfall recharge. In the transient model, the wetland water levels (e.g., the river head in river cells in the wetland) were recharge dependent and varied between 1 to 1.4 m depending on how much rainfall and runoff entered the wetland.*
P30, 6.5.4	What was used to populate the land surface of the evapotranspiration package? It is often the case that ground surface within a model cell varies by >> 1 m (the extinction depth used in this study), and hence, the choice of land surface for the EVT package becomes important. Was the average land surface within each model cell used, or perhaps the centre point?
	Response: An extinction depth of 1 m was used in the EVT package in the model. The surface topography was adopted as the EVT surface in the EVT package.
P30, 6.5.5	Layer 2 is not a clay layer, as suggested here. A continuous clay layer would likely create an effective barrier to vertical flow, and protect the wetland from upward leakage of seawater from the dredge spoils. However, this layer is not described as "clay" in the drilling records. What's more, it seems rather variable.
	Response: The borelogs identify a clayey layer (Layer 2) generally underlying the surficial more sandy unit (Layer 1). Layer 2 comprises sandy clay, clayey silt and clay. *The latest permeability tests confirm that the hydraulic conductivity adopted in the model in Layer 2 is appropriate and within the range suggested by field measurements.* *The in-situ permeability testing summarised in Table 4.3 identify the hydraulic conductivity of sandy/silty clay sediments (i.e. those sediment s mostly mixed with clay) being an order of magnitude less than that for the more sandy sediments. Laboratory testing of undisturbed clay samples by Golders from the clay layer identified as Layer 2 in the model, reported hydraulic conductivity of 4 x 10^{-5} m/day. Based on the results of the field and laboratory testing, the permeability adopted for Layer 2 is consider within the range of hydraulic conductivity values used for the modelling.* *Moreover, the salinity profiles for the bores beneath the Caley Valley Wetland are shown in Figure 4.6 in the report. The salinity profiles for these bores suggest a brackish water lens located above a saline to hypersaline water. This is most likely due the wetland being separated from the groundwater systems underneath by a low conductivity layer as presented in the model.*
P32, 6.6	Layer 2 K values are critical to the study. K values are selected here that are lower than any L values obtained from slug tests, including in Site 1, which is referred to as Silty Clay (expected to have a lower K than "sandy clay" or "clayey sand", which are commonly used to refer to Layer 2). A sceptical reader might presume that it was chosen to minimise vertical leakage. The Sy value of sand/silty sand in the wetland area is far too low, and more representative of a fractured rock aquifer.
	Response: Answered in the previous comment

[1]Ref No.	Issue and response
P33, 6.7.2-6.7.3	It states in 6.7.3 that the steady-state and transient models were calibrated together. I assume that this infers that a composite simulation was constructed – whereby steady-state is simulated first and then transient simulation follows such that the transient simulation uses the steady-state water levels as initial conditions. However, in 6.7.2 and other sub-sections, it refers to the objective and results of the steady-state calibration, as though the steady-state calibration was undertaken separately to the transient calibration. This makes it confusing to understand what was done. PEST does not allow for the user to easily distinguish between steady-state and transient calibration results from a composite calibration. It isn't clear precisely what was done here in terms of steady-state and transient model calibration.
	Response: The steady state and transient models were calibrated together as stated in Section 6.7.2. The calibration targets for the ss model were easily identifiable and were analysed for their corresponding statistics.
P33, 6.7.2	Why was the dry season adopted for steady-state calibration? The water levels from transient measurements do not show a stable period of water levels during dry seasons, so I expect that the dry season is not a steady-state condition. Given this, the steady-state analysis should be treated with caution. In any case, some reasoning for this choice (of dry season) is needed. There also needs to be recognition that dry season water levels may differ from year to year – e.g. Figure 4.4 shows that dry season water levels may differ by >1 m between years. I also have concerns about "matching the direction of groundwater flow". Groundwater flow directions can only be inferred from groundwater levels, and therefore, I suspect that groundwater flow directions have not been targeted specifically via the calibration process – i.e. given that there is no more knowledge of these aside from the information already contained in the head measurements included in the calibration objective function.
	Response: For steady state calibration the average groundwater levels measured in the dry season were used. The dry season water level records were chosen as the simulation of the wetland in place (i.e. during the wet season) would result in unrealistically high water levels away from the wetland due to the steady state result. The transient nature of the wetland is such that its area of influence is expected to be very local. Therefore steady state calibration to anything other than dry season conditions would be erroneous. The transient model simulation starts during a dry season for the calibration and prediction simulation. *Moreover, most of the groundwater levels obtained from Queensland Government bore data base had groundwater levels recorded in dry season. Therefore, inclusion of these records in the steady state calibration required this to be performed on the dry season calibration.* *The comment that the steady state calibration itself was not sufficient enough to calibrate the model is noted, hence combining the steady state calibration with a transient calibration.*
P33, 6.7.2	A discussion of the Queensland Government observation well water levels (from the GWDB) is needed. Were these available for recent times? It seems restrictive not to have measured them to enhance the contemporary water level data set, and to better understand the study area.

[1]Ref No.	Issue and response
	Response: This is not considered material nor relevant to the outcome to the project and report *The groundwater measurements obtained from Queensland Government data base were recorded in different years with some bores having recent groundwater records (2006) and some having recorded groundwater levels as early as 1970. At the time of this study, the measurement of the government bores was not possible.*
P33, 6.7.3	Parameter identifiability ought to be evaluated here. That is, how well are the parameters informed by the field measurements. It may be the case that some of the parameters are not identifiable from the available measurements. Also, RIV conductance was calibrated, but seemingly only for the wetland. What was done about the RIV conductance for watercourses?
	Response: This is not considered material nor relevant to the outcome to the project and report. *There was no field measurement available for the watercourses. Therefore, river conductance values for all the river cells (including the wetland) were calculated through calibration of the model.*
P33, 6.7.4	The minimum and maximum values of the data-sets used to obtain averages should be included in Table 6.3. That is, are the simulated water levels within the range of dry season heads that were used to obtain averages for the purposes of model calibration?
	Response: Average groundwater levels measured in the dry season in the bores were used, and acknowledge that the maximum and minimum groundwater levels could have been included in the table. However this is not considered material nor relevant to the outcome to the project and report *The maximum and minimum can be seen in the transient calibration hydrographs.* *The simulated water levels listed in Table 6.3 are the steady state groundwater levels obtained from the calibrated steady state model for each bore.*
P33, 6.7.4	Given that the model is freshwater only, but the groundwater is hypersaline in places, I suspect that some of the observed water levels need to be density-corrected to be comparable to the density-independent head predictions, albeit, it can be challenging to do this without creating artificial flows when using a density-independent model for a density-dependent problem.
	Response: Density correction was not applied to the recorded groundwater levels.
P33-35, Table 6.3 & 6.7.4-6.7.5	There are some dubious calibration results here that require further explanation and interrogation. The RMS is high, at 1 m, given that most of the water levels are in the range 0 m to 1 m. The RMS error has the units “metres”, rather than dimensionless as given in the text.
	Response: The units for RMS from the calibration is ‘meters’ and RMS appearing in the text with no units is an error in reporting. *While most of the groundwater level measurements ranged between 0 to 1 mAHD, there are other bores included in the steady calibration which have much higher water levels. Therefore RMS of 1 m is considered acceptable for the calibration.*

[1]Ref No.	Issue and response
P35, 6.7.5	The scaled RMS is not especially meaningful for this case, because there are only one or two water levels that control its value. That is, the high water levels at the western limit of the model bias the scaled RMS to a low value, when in fact, the calibration outcome is considerably weaker than 5%, if only the water levels in the area of interest are considered. It seems to be the case that the single water level of 21.6 m is controlling the scaled RMS. Also, the scatterplot has omitted the high values for reasons that are not explained – so it isn't clear whether or not they are included in this calculation.
	Response: It is noted that water levels at the western limit of the model influence the calibration statistics. The majority of the bores are located the project area. Therefore, adding bores in the other areas of the model was necessary to reduce bias in that area and provide meaningful steady state calibration across the entire model domain. *If the single water levels of 21.6 is removed from the calibration analysis, the RMS will reduce to 0.38 m and the SRMS will increase to 5.94%. This is still well within the acceptable range suggested by Australian groundwater modelling guideline (5-10%).* *All the bores listed in Table 6.3 were included in the calibration. However, the scatter diagram was limited to 5m to emphasise the mismatch in water levels near the area of interest.*
P36, Table 6.4	I'm a little confused by the water balance in this table. The wetland and watercourse RIV package fluxes should be separated. It was suggested earlier in the report that RIV cells would only act as drains for watercourses, and also the wetland RIV package was turned off during the dry season. There are major inflows from the RIV package during the steady-state simulation, which is meant to be the dry season, so I'm confused as to how this could have happened. There seems to be mismatches here between the methodology and the results.
	Response: As the river cells in the wetland were switched off during the steady state calibration, the rive budget shown in Table 6.4 is only from minor and major watercourses within the model domain. As it was explained in an earlier response, a 0.5 m head was assigned to the major watercourses in the steady state model. Moreover, some of the river cells (particularly the one adjacent to the shoreline) act as source to the cells with lower elevation. For these two reasons, the RIV inflow reported in Table 6.4 is not unusual nor mismatched between the methodology and the results.
P36, 6.7.6, Appendix E	In Sites 6 and 8, there are unseasonable fluctuations in 2010 that appear as numerical oddities in the modelling results that ought to be explained.
	Response: As it has been explained earlier a transient rainfall data was used in the transient calibration. In 2010, the wet season recorded unusually high rainfall values which were followed with a dry season with no rainfall. The fluctuations seen in the hydrographs are a response of the model to the rainfall. This response can also be seen in other bore such a Site 5 and Site 7.

[1]Ref No.	Issue and response
P36, 6.7.6	The comparison between observed and simulated hydrographs does not indicate that "the model simulates the water level trends well in all of the bores". This is just not the case. Firstly, the biggest trend is seasonality – which is not reproduced well in most cases. Secondly, in the few wells with enough observations to show inter-annual trends, these are not well reproduced – e.g. the inter-annual differences in seasonality in the GW series of wells (e.g. GW01, GW02, GW03, GW04, etc.) are not captured. Otherwise, any inter-annual trends in water levels are difficult to discern from the available data, so it is not possible to make a statement about trend-matching, aside from the general observation that water levels have been largely stable (discounting seasonality) – i.e. appear to occur as a quasi-steady-state condition on average.
	Response: The transient calibration managed to simulate the groundwater levels close to the observed groundwater levels. However, the model could not capture the seasonality to fully match the fluctuations in observation data. For bore such as GW01, GW02 and GW03, the model indeed captured the seasonality but it could not match the peaks recorded in these bores. *It is important to remember, the model built for Abbott Point used one value for conductivity for each geology zone which is a simplified representation of a very complex system. Therefore the model could not capture that level of details and complexity and therefore was not able to match the fluctuations perfectly. Adding more zones and parameters to the calibration could have resulted in a better match, however the non-uniqueness would be a significant issue.*
P39, Tables 6.4 and 6.5	It appears an error that the river leakage is the same in the steady-state model as what it is in the transient model, considering that one is meant to be the dry season and the other is a transient simulation of both dry and wet seasons.
	Response: This is not considered material nor relevant to the outcome to the project and report. *The average river inflow of 0.89 ML/day for transient calibration is correct and it is similar to the steady state prediction of 0.80 ML/day. The RIV budget in Table 6.5 shows the average RIV inflow for the entire duration of transient calibration which includes both dry and wet season. The difference between the two is 0.09ML/day. However it is worth noting that during the wet season while the wetland is active the surrounding areas are receiving additional recharge, resulting in higher water levels in general, and consequently a reduction in leakage from the RIV boundary condition.*
P39, 6.7.7	The steady-state head contours should have been presented prior to the transient head contours.
	Response: It is acknowledged that the steady state heads could have been presented in the report.
P39, 6.7.7	I don't understand what is meant by "Where present", referring to the groundwater level in Layer 1. Is Layer 1 not present everywhere, or are there places where there is no groundwater in Layer 1? It isn't clear.
	Response: There are areas in the model where the groundwater levels simulated for a layer are less that the bottom elevation of that layer or in other word, the layer is unsaturated in those areas. "where present" refers the saturated areas in Layer 1 where groundwater is present.

[1]Ref No.	Issue and response
P39, P6.7.7	The statements here contradict the water balance. The water balance shows that major creeks are leaking into the aquifer – and this is stated below Table 6.4. Now it is stating that they "act as groundwater discharge locations". These statements seem contradictory. Considering that watercourses were treated as groundwater sinks (not sources) in the model further complicates the story here.
	Response: In the model some river cells are source and some are sink to the groundwater system however the net total RIV budgets shows that there is overall inflow from the rivers to the groundwater system
P40, Fig. 6.9	It is odd that Figure 6.9 shows only a small proportion of the modelled area. The whole modelled area needs to be illustrated to properly judge the results.
	Response: A small proportion of the model area was shown in these figures, as the focus was to the show the groundwater flow direction in and around project area. Whilst showing the entire model area in Figure 6.9 would have given a better understanding of the regional groundwater flow direction, the context on a local scale would have been lost.
P41, 6.8.1	At first, it reads as though the dredged material inflows to the aquifer were simulated as recharge fluxes, but later in this section, it seems that they were not, and were simulated using the RIV package. Clarity on this point is important, because the method of simulating the DMCP area will modify significantly the water budget associated with dredge spoils. The ability of the RIV package to properly simulate the infiltration of water from dredged material will depend on careful selection of the conductance parameter and heads in the DMCP zone. Fluxes from the RIV package into the groundwater system should be reconciled with expected water volumes added to the DMCP zone – taking into account the pumping of seawater out of the DMCP area.
	Response: The RIV package was used to simulate the DMCP. *As it is discussed in section 6.8.1, the model represented placement of dredged material and discharge of "excess" water by setting a river package boundary condition across the DMCP footprint to represent the pond operating level and seepage conductance equivalent to the deposited dredged material. The 'river' water level assigned in the RIV package cells within the pond was the operating level of 7.4 mAHD. The river bed conductance was calculated using the hydraulic conductivity of the dredge material which was 0.86 m/day suggested by Golder Associates for dredged material.*
P41, 6.8.1	The seepage conductance in the model is wrong. Firstly, it has the wrong units (it should be "L2/T" not "L/T"). Secondly, it is KLW/M – and not just K, as seems to have been used here.
	Response: Comment noted. The value shown in section 6.8.1 is the hydraulic conductivity of the dredge material (not the seepage conductance) which has a unit of L/T. This is a terminology reporting issue (should not have used seepage conductance) and does not flow through to the model setup which adopts the correct equation for RIV conductance.

[1]Ref No.	Issue and response
P41, 6.8.1	It is expected that the DMCP area will be enclosed, although it isn't clear. The opportunity for surface runoff to occur away from the DMCP area is important in assessing the water balance of this area. For example, will overland flow transport excess rainfall away from the site, or will all rainfall (minus EVT) end up recharging the DMCP area. The RIV package perhaps won't capture the dynamics of recharge to this site, and yet during the wet season, recharge may be high, especially if there is no runoff from the site, and little to no vegetation.
	Response: This is an operational issue for the pond. The instructions from the client were to simulate the design pond level as a constant elevation throughout the dredging period (13 weeks).
P41, 6.8.3	How was rainfall converted to recharge for the prediction scenarios?
	Response: The calibrated recharge rates were a percentage of the rainfall, which was applied to the adopted rainfall data for the predictive model to produce a recharge rate.
P42, Table 6.6	It is unclear how "Layers 1 and 3" can fall under a column titled "Simulation". It is not possible to only simulate those layers. The model requires simulation of all of the layers.
	Response: The model simulated the groundwater regime in all the layers. Table 6.6 provides a summary of the figure showing the results of the simulation presenting the results of the simulation in Layers 1 and 3 only.
P41-42, 6.8 and Table 6.6	I can't follow the prediction scenarios. It is unclear exactly what was done here. In particular, the "Condition" column is confusing. Why would an "end of dredging" simulation be undertaken? Isn't this simply a point in time in the transient simulations?
	Response: The 'Condition' column in Table 6.6 does in fact indicate a particular point in time in the predictive simulation. It is acknowledged that this may seem confusing, but the point of the table was to indicate which scenario and output time could be found on which Figure.
P42, 6.8.3	What were the differences between the three model simulations that represented the no-pond scenarios? It isn't clear – they are referred to as "three model simulations" without adequate description to understand how they were set up and what they were meant to achieve.

[1]Ref No.	Issue and response
	Response: The model was used to assess the impact of climate variability on the predictions. The datasets represented ***low, average and high*** *rainfall regimes respectively. Each scenario model was set up with one of these annual rainfall datasets, which was then repeated throughout the simulation period.* *"Three model simulations" refers to these three climate scenarios (used low, average and high rainfall data set). For each of these climate scenarios, three simulations were carried out for pond design variables:* 1) *'no-pond' simulation where it was assumed DMCP did not exist (the null / baseline model).* 2) *'With pond and liner' where DMCP was included in the simulation and there was a liner around DMCP.* 3) *'with pond without liner' simulations which included DMCP but assumed there was no liner around the pond.*
P42, Table 6.7	The "Height of mounding (m)" needs to be clearer. Perhaps it is the height of the peak water level in the DMCP relative to the height of water in the DMCP without the dredged material, but this should be stated. Equally, the extent of mounding is unclear. The extent of the maximum mounding height is one cell, so what level is used to determine the extent of mounding? Also, I don't understand how there can be a range in the extent of mounding. There needs to be diagram (i.e. a reference to a figure) or clearer explanation so that these numbers can be properly understood.
	Response: Comment acknowledged. The interpretation of the mounding provided in the comment above is correct. *Section 6.8.3 provides discussion that mounding is the change in the groundwater regime due to the DMCP. Similarly this is mentioned in Section 6.8.4 that the groundwater mound represents the difference between the increased groundwater level and that predicted without inclusion of the DMCP. Two simulations were run; one when there was no DMCP and another with DMCP in place. The mounding was calculated using the difference between the predicted groundwater levels and these two simulations.* *The extent of mounding (as a range) provides the mounding's variability when considering all directions away from the pond.*
6.8.4	From Fig. 6.10 to 6.14 it appears that mounding is influenced by the location of the wetland, and therefore, it is likely that there is an inflow to the wetland that occurs due to the dredging operation. This should be recognised, and the fluxes into the wetland should be assessed.
	Response: It is agreed that the wetland plays an important role in the groundwater flow in the project area. As it is shown in Figure 6.10 to 6.14, the extent of mounding reached the north eastern corner of the wetland in layer 1 (particularly for the simulations with no liner), and it extended under the wetland area in Layer 3. The fluxes into wetland were calculated and reported in Table 6.10 in section 6.8.6 of the report.

[1]Ref No.	Issue and response
P43, 6.8.4	The mounding is inferred to extend up to 1 km from the DMCP area. This would bring it in contact with the hypersaline water below the wetland. As such, two things may occur: (a) the hypersaline water is forced upwards into the wetland, and/or (b) the hypersaline water acts as something of a barrier/impediment to the lateral movement of less dense water, originating from the dredged material, thereby forcing it upwards under buoyancy forces.
	Response: It is possible for the mounding from the DMCP to reach the hypersaline water below the wetland, and the comment that there will be an upward movement of water from Layer 3 to Layer 1. However, outside of DMCP, the upward movement of hypersaline water and water originated from dredge material is limited and controlled by the low conductivity clay in Layer 2 of the model.
P43, 6.8.4	The water level rise height that is used to determine the extent of mounding is unclear. It seems that perhaps the value used reduces with time. This would be an odd approach, but I can't work out what else might have been done.
	Response: Comment noted. The calculation of extend of mounding could have been explained more clearly. *We used extend of 1 m mounding contour to calculate the maximum extend of mounding and this approach were used in all the simulations throughout the entire simulation time.* *The mounding reduces with time as the water in the pond start dissipating out of the pond and at the same time evapotranspiration act as mechanism which removes the excess water from the groundwater system.*
P43, 6.8.4	I've mentioned this previously, but again, the manner of simulating the dredged material (RIV package) will produce seepage fluxes that are a-priori unknown, and dependent on aquifer water levels, recharge, and the horizontal flow barrier. These RIV package seepage fluxes should be compared to the volumes of water in dredged materials (e.g. found by multiplying porosity by the volume of dredged material, minus water pumped back out to sea).
	Response: These calculations were examined to confirm the seepage leaving the base of the pit was plausible given the potential for the RIV boundary condition to become an infinite source. The RIV boundary condition provides the best approach to simulating the pond as the seepage volume will depend on the surrounding groundwater levels which in turn are dependent on the seepage rates. Defining the seepage volume prior to the simulation as direct input negates this relationship.
P43, 6.8.4	The evapotranspiration of seepage from the DMCP area will concentrate the seawater. However, the use of the RIV package to simulate the dredged material will not allow for evapo-concentration of seawater in the spoil material. An analysis of evapo-concentration in the DMCP area is warranted, even if only a rough calculation.

[1]Ref No.	Issue and response
	Response: It is agreed that evaporation of seepage will concentrate the seawater. The evapotranspiration was applied to the DMCP area immediately after cessation of dredging, and the impact from evaporation can be seen both in the mounding extent figure and salinity extent figures. Inclusion of EVT in DMCP is highlighted in Section 6.8.1; "To simulate this removal of water, the evaporation boundary condition was re-applied to the DMCP footprint with an evaporation surface equivalent to the proposed final landform (at 6.4 mAHD)." *The estimation of evaporation during the dredging process was irrelevant as the pond will be continuously pumped into with dredge material causing mixing. Salty water will be decanted out of the pond to maintain its operational design (i.e. pond level at 7.4 m height). Therefore if evaporation was applied during the dredging process it will have limited opportunity to evapo-concentrate salts due to the mixing.*
P43, 6.8.4	Here, the statement "where the upper clay layer is present" seems to infer that this layer is not continuous. This is important because discontinuities in this layer are not simulated in the model, and yet may have significant implications for the impacts of the spoil material. Note also that the layer is not referred to as "clay" in most of the bore logs. This is a critical issue. An assessment of a discontinuous "clay" layer as Layer 2 is needed.
	Response: Layer 2 is continuous but includes two different geological zones; 1-granite and 2- Sandy Clay, Clayey Silt, Clay. Therefore, not the entire model area in the layer 2 is clay. "where the upper clay layer is present" refers to areas in Layer 2 where clay exists.
P49, 6.8.5	The term "quasi-steady-state" is misused. It means that the system is oscillating about an unchanging mean. The system has not reached steady-state after the second week, and continues to discharge water for some time after Week 2. It is unclear what the steady-state value might be – most likely less than 4.2 and 3.6 (obtained from Week 13 in Table 6.8).
	Response: Agree that the terminology could be better, as what is being described is a stabilising of the seepage rate as the dredging continues. After Week 13 the dredging is complete and the source of the flow is removed. The seepage rate will reduce with time as the water level declines in the pond with water seeping out.
P49, 6.8.6	In this section, it is inferred that the DMCP is somehow constructed to extend through the upper clay layer. This was not clear in the earlier part of the report. For example, it is not stated in 6.8.1 that the RIV package is applied to Layer 3, and Layers 1 and 2 are somehow made inactive in the DMCP area (this is what would be required to simulate the dredged material sitting atop layer 3). It also states "constructed to the base of Layer 2", so it is in fact unclear what was done to simulate the dredged material.
	Response: The base of DMCP will be constructed on the top of Layer 3. In order to do so, the sand in Layer 1 and clay in Layer 2 within DMCP area will be removed. The model simulated the removal of soil form Layer 1 and 2, through changes in the hydraulic properties of the cells within the DMCP to the hydraulic properties of the dredge material. During the dredging period the RIV package was applied to cells within DMCP in Layer 1, Layer 2, and Layer 3 with a consistent RIV level of 7.4 mAHD.
P50, 6.8.6	There is no need to use a pro-rata calculation. The water budget calculator that works within PMWIN (or groundwater vistas) can be used to compare fluxes to any sections of the wetlands, with and without the dredged material.

[1]Ref No.	Issue and response
	Response: Neither PMWIN nor Groundwater Vistas were used to simulate the groundwater system.
P50, 6.8.6	I disagree that these values (seepage reaching wetland) are upper-end volumes. There has been no sensitivity analysis on the aquifer parameters, and no uncertainty analysis, and therefore no sense of whether considerably higher values are possible from the current knowledge of the system (e.g. with an alternative set of calibrated model parameters).
	Response: The volumes showed in Table 6.10 are the upper-end volumes for the base case scenario. The sensitivity analysis on the aquifer parameters is shown in Section 6.10 of the report. This is discussed in the Section 6.10 which provides an explanation that changing the hydraulic parameters could change the seepage volume from the pond.
P51, 6.9.1	Given that the RIV package was used to simulate the DMCP, how is it that heads were constant? This seems incorrect, and rather, as the dredged material was added to the DMCP area, the heads should have increased. Post dredging, one would expect the head in the DMCP area to naturally attenuate (fall) as the groundwater mound caused by seepage from dredge spoils subsided. Somehow, the RIV package needs a time-varying component to capture this properly. It isn't clear how or whether this was considered or modelled.
	Response: In the model, the river head in the RIV package within the DMCP was set to a constant value of 7.4 mAHD (the maximum height of water in the pond). Given the volume of the pond, the RIV boundary condition could not fill up the pond to 7.4 m height immediately after start of the dredging and therefore it took 2 weeks for the river package to fill up the pond and the water levels in the cells in the pond to reach 7.4 mAHD. From this point on til the end of the dredging process the head in the pond remained at 7.4 mAHD. *After the completion of dredging, the river package in DMCP was turned off. The groundwater levels within the cells in the DMCP where the RIV package was applied are at an elevation of 7.4 mAHD. Without the RIV boundary condition in place the groundwater level is predicted to naturally attenuate over time, as can be seen in the model ouput.*
6.9.1	The estimation of salt transport is potentially misleading. The natural groundwater system has considerable salinities, including hyper-saline groundwater, and therefore, showing salinity versus time trends is not especially meaningful with strong caveats. There needs to be a stronger expression of caution and explanation around this section, to highlight that none of the predicted salinities can be considered as potentially real-world values. They merely identify the extent to which the seawater may travel away from the DMCP area, albeit without the important density effects that are likely to modify significantly the results. Even the title "predictive salinity transport simulations" is potentially misleading. The worst of the misguidance is on P54, where it is referring to "predicted range of salinity concentrations" and uses other words that indicate that perhaps the predicted salinities might be found in the future. There is no chance of this – the salinities expected to occur in the study area in the future will depart significantly from the constant 5000 that was used in the model. The effect of dispersion will in fact be in the opposite direction to that simulated – i.e. the water below the wetland is saltier, not fresher, than the dredged water.

[1]Ref No.	Issue and response
	Response: The salinity modelling is not considered to be misleading. The assessment report acknowledges that the natural groundwater system has considerable salinities, including hyper-saline groundwater (in deeper aquifers). *The purpose of the salinity modelling was to investigate the additional salinity added to the system from the DMCP and its potential impact (extent and additional concentration) on the receiving environment. The modelling is about providing a tool which has captured enough of the real system through necessary simplifications to be useful, and then using this tool to predict potential impacts and inform decisions.* *Providing an initial background concentration of 5000 mg/L allows the DMCP seepage of sea water to migrate away from the pond and provide a likely upper bound to the extent. If a hyper-saline concentration was applied to Layer 3, the concentration from the dredge material seepage would be contained within DMCP, and possibly reduce the local concentration if mixing could occur. As such the modelling is considered to provide a conservative approach.*
P56, 6.10	I can't see how parameters can be sensitive to impacts from changes in groundwater discharge. Surely, it is the mounding that is sensitive to the value of the parameter, and not the reverse. The parameter will only be sensitive to the mounding in a modelling situation involving calibration of the parameter, where the mounding is somehow measured and is a calibration target.
	Response: Comment acknowledged. The hydraulic parameters are not sensitive to the mounding and the impacts. It is the impacts and mounding which are sensitive to hydraulic parameters.
P56, 6.10	I disagree that K values are known within half an order of magnitude. There are no pump test values that give the K for Layer 2, and no testing of storage parameters has been undertaken at all.
	Response: It is acknowledged that there was limited field data available. However, the sensitivity analysis changed the values such that they remained within a meaningful range for each hydraulic property in the model.
P56, 6.10	It would help to add a more precise explanation of what is meant by half an order of magnitude. Is it supposed to mean "multiplied by 5" and "divided by 5"?
	Response: Comment noted. The assumption of ± half order magnitude meaning "multiplied by 5" and "divided by 5" in the comment above is correct.
P57, 6.10.1, Table 6.12	It is not logical to consider the sensitivity of storage parameters to steady-state predictions. S is not in the steady state equation. Including it in Table 6.12 gives the impression that the authors are not aware of this.
	Response: Comment noted.
P58, 6.10.1	The fact that the objective function increased when parameters changed does not indicate that these parameters are less plausible. One could only say that if every other parameter in the model, aside from the changed parameter, was perfectly known, then the increase in the objective function can be related to the plausibility of the parameter. But this is not the case. Rather, the non-uniqueness in the model, where recharge and K are coupled, means that more plausible K values are possible with equally plausible recharge values, and vice versa.

[1]Ref No.	Issue and response
	Response: It is agreed that the particular hydraulic conductivity tested in the sensitivity analysis could be plausible, however when combined with the other parameters in that particular model run it results in a lesser fit to the observation data, and therefore can be considered less likely for that particular parameter set.
P58, 6.10.1	Unless regularisation was used (preferred values), field measurements and published data did not constrain parameter values. These values are more likely the outcome of the initial values given to PEST, and the field measurements which are included in PEST's objective function, plus other factors, such as the manner in which PEST was used and whether or not over-fitting occurred.
	Response: Given the simplifying assumptions applied across the geologies, it is unlikely that 'over-fitting' occurred during the calibration.
P58, 6.10.1	The statement about the insensitive storage parameters and non-uniqueness is not a logical sentence. A parameter can be very sensitive but be extremely non-unique. These two aspects are not linked in the way they have been described here. Also, it is not necessarily a good outcome that a parameter is insensitive to calibration, because if the parameter has a significant influence on prediction, it means that the predictions are more uncertain.
	Response: Comment noted and it is agreed that the sentence could be reworded. The last sentence above is the point that was being conveyed in the report.
P58, 6.10.1	There is no basis for the statement that the seepage values are improbable extremes. The modellers have adopted one set of aquifer parameters when an infinite number of possible parameter combinations exist. If PEST had been used to seek a plausible set of parameter values that produce a maximum rate of seepage (i.e. hypothesis testing), I have no doubt that far more extreme seepage rates could have been obtained than those given here.
	Response: Hypothesis testing was not undertaken. The comment on seepage values not being improbable extremes is noted. Describing the predicted seepage rates from parameter sets that do not adequately calibrate the model as 'less likely' is perhaps more correct.
P59, 6.10.2	Here, it states that the extent of mounding was defined by the 1 m or more mounding zone, and refers to 6.8.4. I am unable to find where this is explained in 6.8.4.
	Response: Section 6.10.2 is referring the readers to find the <u>definition of mounding</u> in section 6.8.4 as "The groundwater mound contours represent the difference between the increased groundwater level and that predicted without inclusion of the DMCP (i.e. 'no-pond' scenario)."
P59, 6.10.2	Again, the statement about improbable extreme is unfounded if fundamental concepts of model calibration are adhered to.
	Response: Again, 'less likely' may be a more appropriate descriptor given the model has become less calibrated after the change.
P59, 6.10.3	This sensitivity classification is no longer recommended, according to the author of the earlier groundwater modelling guidelines, Dr Noel Merrick. Dr Merrick, in a recent court case, stated that he was unaware of examples of abuse of the method until that time. The current report is another example of this, in particular given that there are no values offered to defend the statements here about the various Types.

[1]Ref No.	Issue and response
	Response: At the time of reporting, the issue with the sensitivity classification was not known to the authors. It is agreed that the sensitivity classification (Section 6.10.3) should be removed from the report.
P61, 6.11	I disagree with the statement that "conservative parameters were adopted". I see no evidence for this.
	Response: The terminology of 'conservative parameters' should not have been used in this instance. On reflection that particular sentence could be removed from the report.
P61, 6.11	The water levels in the wetland were not fixed per se, but were represented by the RIV package, which was apparently turned off during the dry season. Perhaps the RIV package wasn't turned off during the dry season, as suggested in the methodology. It isn't clear. Also, I can't see how 1 m AHD and 1.4 m AHD are reasonable values when there are water levels below sea level in monitoring wells near the wetland. Where did these two values come from?
	Response: As indicated in the comment, the terminology used in that sentence of 'fixing' does not represent how it was implemented in the model. The use of 'fixing' here was to describe the process of assigning this value for stress periods prior to the simulation running. The water level in the RIV boundary condition remained constant for the wet season it represented. When the wet season was over the RIV boundary condition was removed and evaporation was applied to the wetland area, resulting in water levels declining to less than 0 mAHD in some areas. *It is not clear why the comment is suggesting the RIV package was not turned off during the dry season.* *The depth of water in the wetland between 1 and 1.4 m as lower and upper bound were obtained from, field observation, the previous surface water studies on the wetland and also the surface topography of the wetland.*
P68, 7.7	It states here that the mound will not produce surface seepage, but this relies on an effective construction of a horizontal barrier to flow around the DMCP perimeter, a continuous and low-permeability Layer 2, and a high evaporation rate that maintains water levels below ground surface. The study shows significant evapo-concentration of seepage water, and therefore, while there may not be surface seepage, the evapo-concentration demonstrates that there are effects of the dredge seawater on the unsaturated zone around the DMCP area, particularly for the cases that don't include a liner.
	Response: This statement is acknowledged and the report identifies the benefit of a including a horizontal barrier around the perimeter of the DMCP (refer Section 6.8.6). Whilst the continuity of Layer 2 is unknown, it presence has been based on previous geology data sourced from the Connell Hatch geotechnical studies in 2009. (refer Section 6.3), and the results of the more recent studies by Golders and AGE. *Surface water expression of seepage through the base of the DMCP is not predicted to occur. However, given the potential sensitivity of the wetland, the hydrology assessment considered a hypothetical 'worst-case' scenario, where surface expression occurred and saline waters entered the wetland (Volume 2, Section 4.3.6.3; Volume 3, Appendix O). The assessment concluded that the saline waters at the discharge location may result in highly localised changes to fringing wetland vegetation in affected areas, with the possibility for salt-tolerant samphire communities to be temporarily replaced by salt sensitive saltcouch in affected areas. This impact was predicted to be temporary, highly localised and therefore unlikely to affect the functionality of aquatic habitats within the wetland.*

[1]Ref No.	Issue and response
P68, 7.8	While it states here that the saline groundwater seepage is not expected to impact the wetland, the threat of forcing hypersaline groundwater into the wetland, due to the pressure loading of the subsurface caused by the placement of dredged material, has not been assessed. Also, while the modelling suggests that seepage will be restricted to Layer 3, this is predicated on the assumption of a continuous low-permeability clay layer throughout the study area.
	Response: This statement is acknowledged and AGE agrees with the comments made. Predicted impact due to pressure loading by the dredge material is outside the scope of work undertaken by AGE. Response to comment on the continuity of the clay (Layer 2) has already been discussed in Submission P68, 7.7.
P69, 8	The Aims of the GMMP are supported.
	Response: No response required.
P69, 8	It is preferable not to presume the outcome of the monitoring process before monitoring has been undertaken. That is, it seems rather unscientific to state that: "the groundwater monitoring will provide a basis for identifying that the dredged material and resultant seepage will have a low to negligible impact on the adjacent wetland areas." This statement presumes an outcome without having taken the measurements. Rather, it would be preferable to design the monitoring network for possible incidences that might occur, taking into account the potential for uncertainty (and related error) in the conceptualisation and numerical model.
	Response: This statement is acknowledged. The purpose of this statement is to undertake monitoring to confirm that what the groundwater modelling has predicted occurs. The following paragraph provides statement that further investigation/ assessment would be required "In the event that groundwater monitoring indicates divergence from the results predicted by this assessment".
P69-70, 8	In general terms, the recommendations for monitoring are non-specific, and allow for a wide range of future monitoring. There is no mention of key knowledge gaps, such as the lack of surface water monitoring (levels, flows and water quality), knowledge of water levels to the south, the value of groundwater heads along the shoreline, etc. Also, remedial measures can be speculated – e.g. pumping groundwater to reduce seepage levels if surface or wetland impacts occur (albeit, management of the pumped groundwater would need to be considered). A more authentic and detailed monitoring strategy should be devised, because otherwise, it is possible to undertake only scant new work and yet have acted in accordance with the Recommendations of this report
	Response: This section provides recommendations for the development and implementation of a groundwater monitoring and management plan (GMMP). The comments provided in this submission are acknowledged.

Appendix D

Technical Memorandum - ASS Testing of Historical Offshore Samples

Advisian
WorleyParsons Group

Queensland Government

Golder Associates

TECHNICAL MEMORANDUM

DATE 7 August 2015 **PROJECT No.** 1525905-060-TM-Rev0

TO Project Manager
Department of State Development

CC Neil Underhill

FROM Russell Merz **EMAIL** RMerz@golder.com.au

ABBOT POINT GROWTH GATEWAY
ASS TESTING OF HISTORICAL OFFSHORE SAMPLES

At the Abbot Point Growth Gateway project, dredged material from the T0 berth and apron areas will be placed in the dredged material containment ponds (DMCP). Post-dredging, the dredged material may remain in the DMCP for some time. Over time, the dredged material will be subject to both drainage and surface evaporation, resulting in a caked crust which will crack and provide oxidized conditions around the cracks. Where Potentially Acid Sulfate Soil (PASS) is present, this can result in acid formation in these exposed materials.

However, the previous characterisation of recovered offshore materials at Abbot Point (GHD, 2012c) has indicated that the marine sediments were PASS with a natural neutralising capacity greater than the acid generating capacity, likely due to the presence of shell and other calcareous materials throughout the sediment. This suggests that these marine sediments are “self-neutralising”.

To assist in characterising the possible behaviour of the “self-neutralising” dredged material when stored in the DMCP, a number of vibrocore and soil core samples from previous 2011 offshore investigations (GHD 2012a, 2012b) were identified in storage at Abbot Point and have subsequently been assessed. These soil samples included both darker hued, marine sediments and lighter hued deposits of consolidated alluvium/residual soils which are expected to be similar to the materials to be dredged from the T0 berth and apron. The unrefrigerated historical storage of marine sediments is expected to simulate possible post dredging conditions within the DMCP.

The assessment completed included visual observations and laboratory testing as summarised below:

- Vibrocore Samples – (20 samples from MCF offshore investigation locations marked on Figure 1)
  - Open each sample bag and inspect for the presence of jarosite or iron staining to evaluate if acid has been generated and subsequently neutralised, and then photograph.
  - Collect 100g subsample from all bags except VC401-31A 4.2-4.3m, VC401-23B 2.8-2.9m and VC401-33 3.5-3.9m (deeper deposits of stiffer soils) i.e. 17 samples. Remove any visible shell fragments greater than about 3mm. Place sample in lock sealed and labelled bag.
  - Conduct Chromium Suite tests on the 17 samples to give current pH and existing acidity to compare against previous GHD testing.

- Soil Cores (GHD BHW2-02, 03 and 09 marked on Figure 2)
  - Core trays were opened and cores were inspected for the presence of jarosite or iron staining and then photographed.
  - Collect 100g subsample from the top of each of these holes (3 samples).
  - Conduct Chromium Suite test on above 3 samples. These are aimed at demonstrating the absence of ASS in the stiffer non-marine sediments.

Visual Observations

Attachment 1 shows photographs of the soil samples in July 2015 presented alongside vibrocore photographs from 2011. The following general observations were made:

- All samples appeared drier than indicated in 2011 photographs.
- Some iron staining was observed in all marine sediment samples in 2015 (no iron staining was noted when the samples were collected in 2011). *This suggests that some acid formation and neutralisation has occurred within these bagged samples since 2011*.
- Possible new iron staining was observed in some of the alluvium/residual soil samples inspected in 2015 in comparison to the 2011 photographs (where iron coloured mottling was generally present to some degree). Although this may have been present but not obvious in the 2011 photographs.
- No jarosite was observed in any of the samples.
- Large coral and shell fragments were typically present in the marine sediment samples. The sand fraction of these samples also appeared to be predominantly comprised of shell grit.

Laboratory Test Results

Laboratory test certificates are presented in Attachment 2 and the results are summarised in Table 1 along with previous test results from this area in 2011. A statistical summary of marine sediment results is also included in this table.

The results of the current testing indicate the following:

- pH in marine sediments are generally similar to those measured in 2011 with drops of less than 0.1 pH unit and increases of up to 0.3 pH units. pH in all samples remains above 9.

  This indicates that alkaline conditions continue to dominate in these soils.
- No existing acidity was detected in any of the samples analysed.

  For the marine sediment samples, this indicates that any acid that was generated whilst these materials were in storage (as evidenced by the iron staining) has been neturalised and that alkaline conditions continue to dominate in these soils.
- All marine sediment samples had Chromium Reducible Sulfur concentrations above QASSIT Action Levels.

  The presence of PASS in these marine sediments is confirmed.
- All marine sediments had acid neutralising capacities (following removal of large shell and coral fragments) ranging from 4 to 200 times their acid generating potential.

  This indicates that these sediments are "self-neutralising".
- It is noted that if the acid neutralising capacity was *not* included in net acidity calculations, then lime treatment rates in the order of 3 to 12 kg of lime per m^3 would be required to neutralise the potential acidity within these marine sediments.
- All alluvium/residual soil samples had Chromium Reducible Sulfur concentrations below QASSIT Action Levels.

  The absence of PASS in the alluvium/residual soil samples is confirmed.

The results of other historical tests on marine sediments from the proposed T0, T2 and T3 apron dredging areas from 2012 are summarised in Table 2. A statistical summary of these results is also provided. This summary indicates that the 2012 T0, T2 and T3 area samples have similar PASS characteristics to those from the recent tests on vibrocore samples apart from slightly higher Chromium Reducible Sulfur concentration across the T0 apron.

CONCLUSIONS

The following conclusions can be drawn from the observations and testing conducted on stored offshore samples:

Marine Sediments

- All of the samples of stored marine sediments analysed were confirmed to be self-neutralising PASS. These findings are similar to those identified in previous offshore marine sediment sampling programs from Abbot Point.
- The presence of iron staining in these bagged samples indicates that some oxidisation and acid generation has occurred during the 4 years of storage and that this acid has been neutralised within these alkaline soils. This also suggests that relatively low levels of acid generation will occur whilst these soils are stored in a saturated to semi-saturated condition.
- The stored marine sediments continue to have a potential to generate additional acid but have significant neutralising capacity, well in excess of the potential acid generation (ie. self-neutralising soils are indicated). Again this suggests that oxidisation and hence acid generation is relatively minor whilst these materials are stored in a saturated to semi-saturated condition.
- It is noted that if acid neutralising capacity is not considered (e.g. conservatively simulating segregation during dredging, settlement of only the finer sediment fractions in the secondary containment pond, limited availability of shell and coral fragments), and ignoring the buffering effect of seawater within the ponds on the dredged material, then potential liming rates range from 3 to 12 kg of lime per m^3 (with a 95% UCL of 9 kg lime per m^3) would be required to neutralise the potential acidity within these marine sediments. Using this same rationale, historical results on offshore samples from T0, T2 and T3 aprons suggests a range of potential liming rates from 2 to 32 kg of lime per m^3 (with a 95% UCL of 10 kg lime per m^3).

Alluvium/Residual Soils

- All 12 samples of alluvium/residual soils tested had Chromium Reducible Sulfur concentrations below QASSIT Action Levels and confirm the absence of PASS in these underlying soils.

REFERENCES

GHD. 2012a. Abbot Point Multi Cargo Facility - Offshore Geotechnical Investigations - Factual Geotechnical Report, May 2012, Report No. 41-23408-C-RP-003 Rev. 2

GHD. 2012b. Hancock Wharf and Trestle - Offshore Geotechnical Investigation Factual Geotechnical Report, May 2012, Report No.: 41-23408-C-RP-004 Rev.0

GHD. 2012c. Abbot Point, Terminals 0, 2 and 3 Capital Dredging Sediment Sampling and Analysis Plan Implementation Report, GHD July 2012.

PKS/RDM/ps

Attachments: Figure 1 – Vibrocore Locations
Figure 2 – Soil Core Locations
Table 1 – Summary of Acid Sulfate Test Results
Table 2 – Summary of Historical Acid Sulfate Test Results T0, T2 and T3 Aprons
Attachment 1 – Sample Photographs
Attachment 2 – Laboratory Certificates

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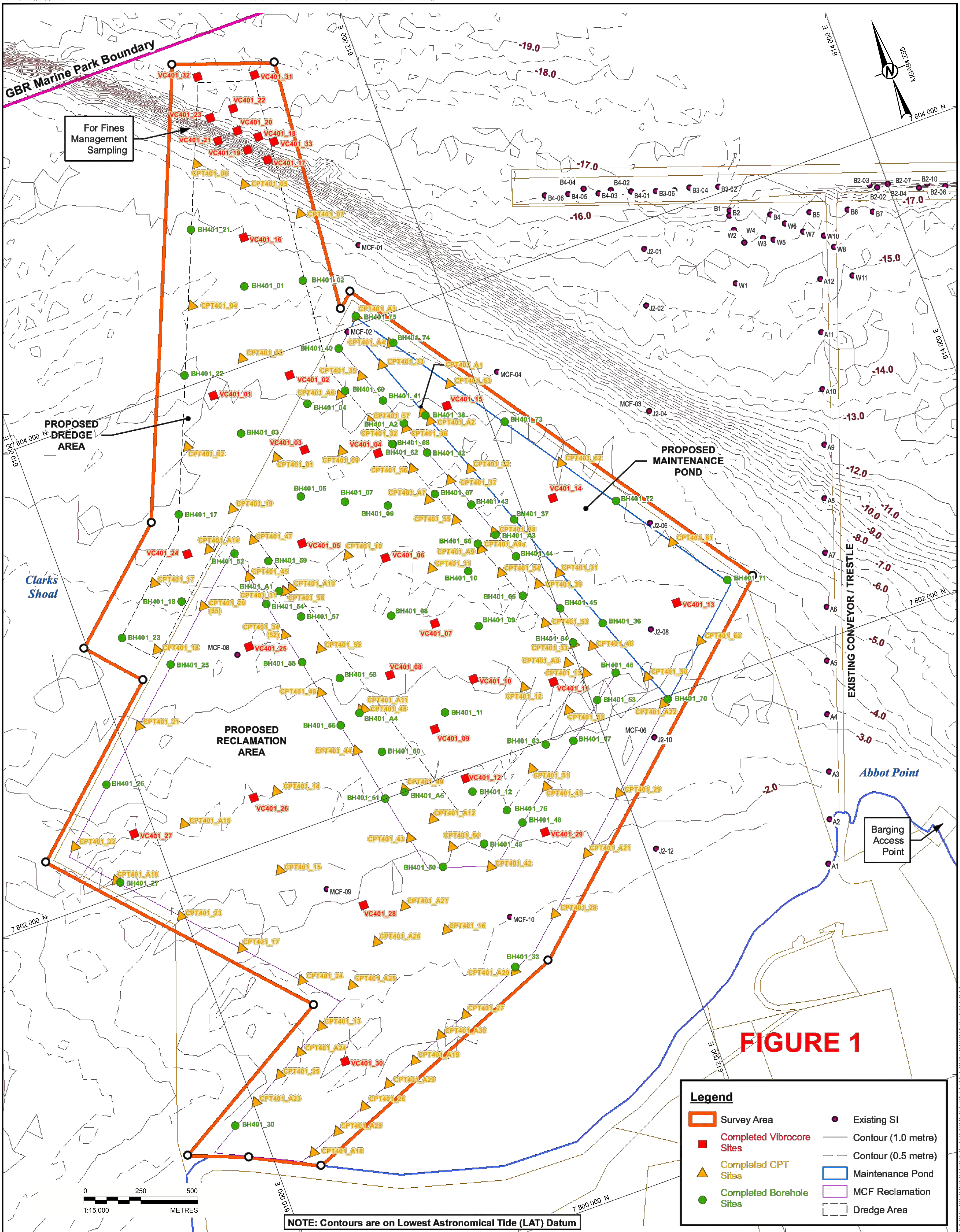

REFERENCE(S)
BASE MAP TAKEN FROM GHD DRAWING 41-23408_006_marineGeophysWorks_BH_CPT_revX.mxd DATED 2011-12-01 : Abbot Point Multi Cargo Facility - Offshore Geotechnical Investigations - Factual Geotechnical Report, May 2012, Report No. 41-23408-C-RP-003 Rev. 2

CLIENT
DEPARTMENT OF STATE DEVELOPMENT

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-08-06
DESIGNED	GPG
PREPARED	DCR
REVIEWED	AMB
APPROVED	RDM

PROJECT
ABBOT POINT GROWTH GATEWAY PROJECT
DREDGED MATERIAL CONTAINMENT PONDS

TITLE
INVESTIGATION HOLES WORKS, COMPLETED 01 DEC 2011

PROJECT NO.	DOC No.	REV.	FIGURE
1525905	060	0	F001

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3
25 mm

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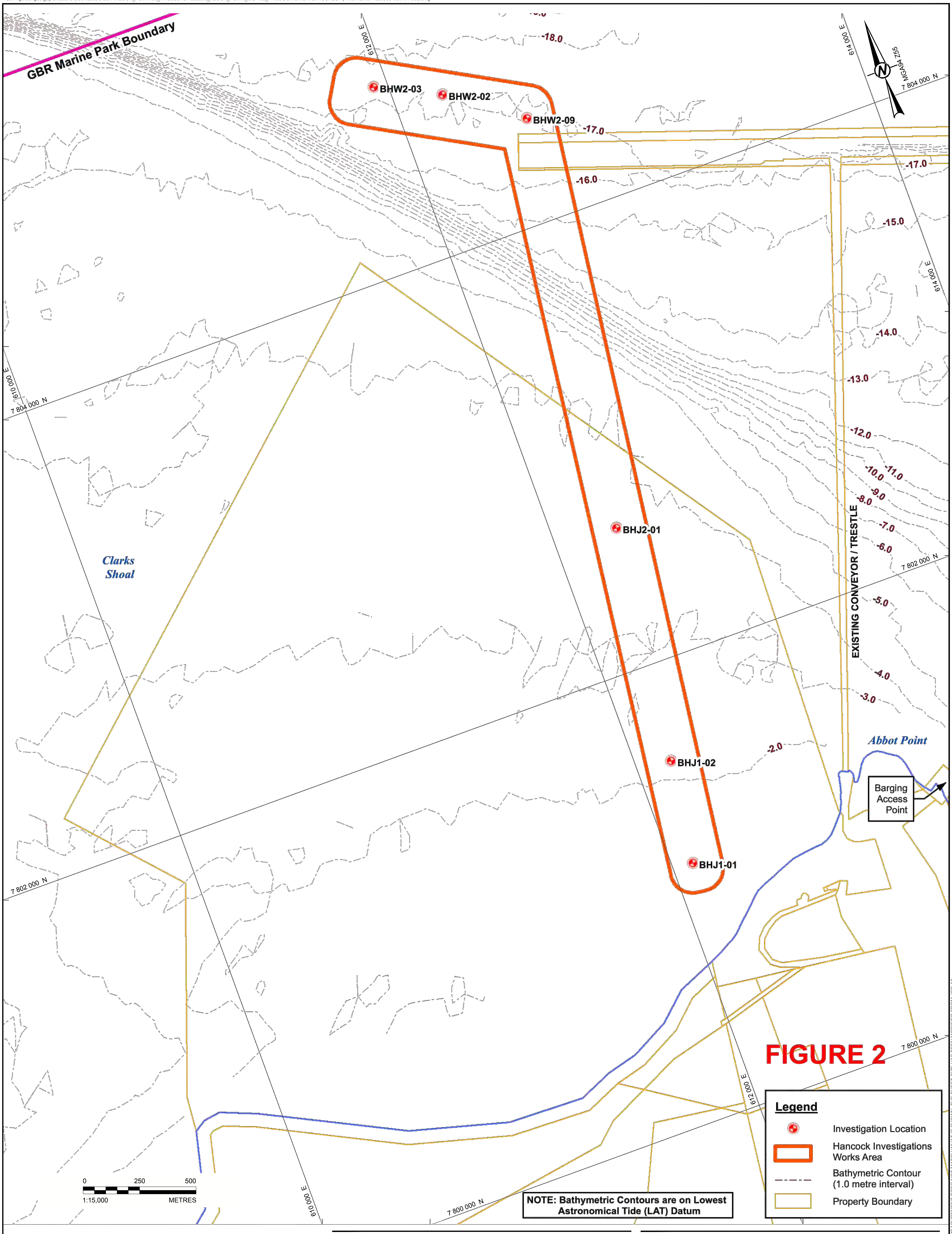


FIGURE 2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

0 25 mm

REFERENCE(S)

BASE MAP TAKEN FROM GHD DRAWING 41-23408_019_Geophys_Hancock_BHs_revA.mxd DATED 2012-03-26 : Hancock Wharf and Trestle - Offshore Geotechnical Investigation Factual Geotechnical Report, May 2012, Report No.: 41-23408-C-RP-004 Rev.0

CLIENT
DEPARTMENT OF STATE DEVELOPMENT

PROJECT
ABBOT POINT GROWTH GATEWAY PROJECT
DREDGED MATERIAL CONTAINMENT PONDS

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-06-08
DESIGNED	GPG
PREPARED	DCR
REVIEWED	AMB
APPROVED	RDM

TITLE
GEOTECHNICAL INVESTIGATION LOCATIONS

PROJECT NO.	DOC No.	REV.	FIGURE
1525905	060	0	F002

Table 1: Summary of 2011 and 2015 Acid Sulfate Test Results

Test Location	Depth Range (m - BGL)		Material Description	pH_{FIELD} (GHD, 2012a)	pH_{FOX} (GHD, 2012a)	pH_{KCl} 2015 (Golder)	sTAA Converted to %S*	S_{NAS} (if pH less than 4.5)	Existing Acidity %S (sTAA + 0.75 x S_{NAS})	Chromium Reducible Sulfur (S_{CR}) %S	Acid Neutralising Capacity %CaCO3 (if pH more than 6.5)	Net Acidity %S (S_{CR}+Existing Acidity - ANC/FF)	Is This AASS	Is This PASS	Liming Rate for Net Acidity (kg/m3)	Liming Rate for Net Acidity Ignoring ANC (kg/m3)
VC401-18	0.00	0.10	Sand (Marine)	9.10	7.20											
VC401-18	0.40	0.50	Sand (Marine)	9.20	6.90											
VC401-18	0.90	1.00	Sand (Marine)	9.20	6.80											
VC401-18	1.40	1.50	Sand (Marine)	9.20	7.60											
VC401-18	**1.70**	**1.80**	Sand (Marine)			9.1	**< 0.020**		**0.000**	0.153	**24.3**	**-2.442**	**No**	**YES**	**No Additional Lime Required**	**11.6**
VC401-18	1.90	2.00	Sand (Marine)	9.20	8.20											
VC401-18	2.40	2.50	Silty SAND (Marine)	9.40	5.20											
VC401-18	2.90	3.00	Clayey SAND (Residual)	9.50	7.00											
VC401-18	3.40	3.50	Clayey SAND (Residual)	9.30	9.30											
VC401-18	**3.60**	**3.70**	Clayey SAND (Residual)			9.3	**< 0.020**		**0.000**	**< 0.005**	**42.8**	**-4.571**	**No**	**No**	**NA**	**NA**
VC401-18	3.90	4.00	Sandy gravely CLAY	9.30	9.80											
VC401-18	4.40	4.50	Sandy gravely CLAY	9.20	9.60											
VC401-18	**4.50**	**4.90**	Sandy gravely CLAY			9.1	**< 0.020**		**0.000**	**0.005**	**34.7**	**-3.706**	**No**	**No**	**NA**	**NA**
VC401-18	4.90	5.00	Sandy gravely CLAY	9.20	9.60											
VC401-18	5.25	5.35	Sandy CLAY	8.90	5.80											
VC401-20	**3.70**	**3.80**	Clayey SAND (Residual)			9.3	**< 0.020**		**0.000**	**< 0.005**	**45.2**	**-4.828**	**No**	**No**	**NA**	**NA**
VC401-22	0.00	0.10	Clayey SAND (marine)	9.00	6.90											
VC401-22	0.40	0.50	Clayey SAND (marine)	9.20	6.80											
VC401-22	0.90	1.00	Clayey SAND (marine)	9.20	7.10											
VC401-22	1.40	1.50	Clayey SAND (marine)	9.10	6.80											
VC401-22	**1.60**	**1.70**	Clayey SAND (marine)			9.1	**< 0.020**		**0.000**	0.116	**1.36**	**-0.029**	**No**	**YES**	**No Additional Lime Required**	**8.8**
VC401-22	1.90	2.00	Clayey SAND (marine)	8.90	6.70											
VC401-22	2.40	2.50	Clayey SAND (marine)	9.30	6.80											
VC401-22	**2.70**	**2.90**	Clayey SAND (Residual)			9.3	**< 0.020**		**0.000**	**< 0.005**	**36.4**	**-3.888**	**No**	**No**	**NA**	**NA**
VC401-22	2.90	3.00	Clayey SAND (Residual)	8.80	6.80											
VC401-22	3.40	3.50	Clayey SAND (Residual)	8.70	9.20											
VC401-22	**3.50**	**3.90**	Clayey SAND (Residual)			9.3	**< 0.020**		**0.000**	**< 0.005**	**40.8**	**-4.358**	**No**	**No**	**NA**	**NA**
VC401-22	3.90	4.00	Clayey SAND (Residual)	8.80	9.50											
VC401-22	4.40	4.45	Clayey SAND (Residual)	9.00	6.60											
VC401-23B	0.00	0.10	Clayey SAND (marine)	9.00	6.90											
VC401-23B	**0.20**	**0.30**	Clayey SAND (marine)			9.4	**< 0.020**		**0.000**	0.047	**29.7**	**-3.125**	**No**	**YES**	**No Additional Lime Required**	**3.6**
VC401-23B	0.40	0.50	Clayey SAND (marine)	9.20	6.90											
VC401-23B	0.90	1.00	Clayey SAND (marine)	9.20	6.90											
VC401-23B	1.40	1.50	Clayey SAND (marine)	9.40	6.50											
VC401-23B	1.90	2.00	Sand	9.60	6.20											
VC401-23B	**2.10**	**2.40**	Clayey SAND (Residual)			9.4	**< 0.020**		**0.000**	**0.008**	**27.2**	**-2.905**	**No**	**No**	**NA**	**NA**
VC401-23B	2.40	2.50	Clayey SAND (Residual)	9.20	6.80											
VC401-23B	2.90	3.00	Sandy CLAY (residual)	9.20	6.70											
VC401-31A	0.00	0.10	Clayey SAND (marine)	9.10	7.30											
VC401-31A	0.40	0.50	Clayey SAND (marine)	8.80	7.00											

Table 1: Summary of 2011 and 2015 Acid Sulfate Test Results (continued)

Test Location	Depth Range (m - BGL)		Material Description	pH_{FIELD} (GHD, 2012a)	pH_{FOX} (GHD, 2012a)	pH_{KCl} 2015 (Golder)	sTAA Converted to %S*	S_{NAS} (if pH less than 4.5)	Existing Acidity %S (sTAA + 0.75 x S_{NAS})	Chromium Reducible Sulfur (S_{CR}) %S	Acid Neutralising Capacity %CaCO3 (if pH more than 6.5)	Net Acidity %S (S_{CR}+Existing Acidity - ANC/FF)	Is This AASS	Is This PASS	Liming Rate for Net Acidity (kg/m3)	Liming Rate for Net Acidity Ignoring ANC (kg/m3)
VC401-31A	**0.60**	**0.70**	Clayey SAND (marine)			9.1	< 0.020		0.000	0.119	16.5	-1.643	No	YES	No Additional Lime Required	9.0
VC401-31A	0.90	1.00	Clayey SAND (marine)	9.10	6.90											
VC401-31A	1.40	1.50	Clayey SAND (Residual)	8.90	6.80											
VC401-31A	**1.60**	**1.70**	Clayey SAND (Residual)			9.4	< 0.020		0.000	0.025	35.8	-3.824	No	No	NA	NA
VC401-31A	1.90	2.00	Clayey SAND (Residual)	9.30	6.90											
VC401-31A	2.40	2.50	Clayey SAND (Residual)	9.20	7.00											
VC401-31A	2.90	3.00	Clayey SAND (Residual)	8.60	8.80											
VC401-31A	3.40	3.50	Clayey SAND (Residual)	8.90	9.50											
VC401-31A	3.90	4.00	Clayey SAND (Residual)	8.90	9.60											
VC401-32	0.00	0.10	Clayey SAND (marine)	9.00	6.90											
VC401-32	0.40	0.50	Clayey SAND (marine)	9.00	6.90											
VC401-32	**0.70**	**0.80**	Clayey SAND (marine)			9.4	< 0.020		0.000	0.056	26.4	-2.764	No	YES	No Additional Lime Required	4.2
VC401-32	0.90	1.00	Clayey SAND (marine)	9.00	6.80											
VC401-32	1.40	1.50	Clayey SAND (marine)	9.20	7.00											
VC401-32	**1.60**	**1.70**	Clayey SAND (marine)			9.3	< 0.020		0.000	0.048	25.6	-2.686	No	YES	No Additional Lime Required	3.6
VC401-32	1.90	2.00	Sand	9.20	6.80											
VC401-32	2.40	2.50	Sand	9.00	6.70											
VC401-32	2.90	3.00	Clayey SAND (Residual)	9.10	7.10											
VC401-32	**3.20**	**3.30**	Clayey SAND (Residual)			9.4	< 0.020		0.000	0.029	47.6	-5.084	No	No	NA	NA
VC401-32	3.40	3.50	Clayey SAND (Residual)	9.20	7.10											
VC401-32	3.90	4.00	Clayey SAND (Residual)	9.20	7.10											
VC401-32	4.40	4.50	Clayey SAND (Residual)	8.90	6.00											
VC401-33	0.00	0.10	Clayey SAND (marine)	8.90	7.00											
VC401-33	0.40	0.50	Clayey SAND (marine)	9.10	6.90											
VC401-33	**0.50**	**0.90**	Clayey SAND (marine)			9.4	< 0.020		0.000	0.072	31.9	-3.335	No	YES	No Additional Lime Required	5.4
VC401-33	0.90	1.00	Clayey SAND (marine)	9.20	7.00											
VC401-33	1.40	1.50	Clayey SAND (marine)	9.00	6.90											
VC401-33	**1.70**	**1.80**	Clayey SAND (marine)			9.2	< 0.020		0.000	0.140	25.8	-2.616	No	YES	No Additional Lime Required	10.6
VC401-33	1.90	2.00	Clayey SAND (marine)	9.10	7.20											
VC401-33	2.40	2.50	Clayey SAND (marine)	9.60	6.70											
VC401-33	**2.70**	**2.80**	Clayey SAND (marine)			9.5	< 0.020		0.000	0.052	2.39	-0.203	No	YES	No Additional Lime Required	3.9
VC401-33	2.90	3.00	Clayey SAND (marine)	9.60	6.80											
VC401-33	3.40	3.50	Clayey SAND (Residual)	9.20	6.90											
VC401-33	3.90	4.00	Clayey SAND (Residual)	9.00	7.30											
VC401-33	4.40	4.50	Clayey SAND (Residual)	9.00	7.10											
VC401-33	4.90	5.00	Clayey SAND (Residual)	8.90	9.70											
BHW2-02	**0.95**	**0.99**	**Stiff CLAY**			9.50	< 0.020		0.000	0.007	47.8	-5.098	No	No	NA	NA
BHW2-03	**0.95**	**1.00**	**Stiff Sandy CLAY/Clayey SAND**			9.30	< 0.020		0.000	0.005	48.8	-5.207	No	No	NA	NA
BHW2-09	**1.06**	**1.10**	**Clayey SAND (marine)**			9.10	< 0.020		0.000	0.04	19	-1.989	No	YES	No Additional Lime Required	3.0

Input By: SB
Date: 27/07/2015
Checked By: PS
Date: 27/07/2015

Note: Liming rates assume a bulk density of 1.60 t/m3
Fineness Factor = 3
Bold text is from Golder 2015 testing
Regular text is from GHD, 2012a
BHW2 series samples are from GHD, 2012b

Statistical Summary	Chromium Reducible Sulfur (%S)	Net Acidity (%S)	Lime Treatment Rate excluding ANC (kg lime/m3)
Marine Sediment Statistical Summary MCF			
Sample count	9	9	9
Average concentration	0.089	-3.059	6.7
minimum concentration	0.047	-5.084	3.6
maximum concentration	0.153	-0.029	11.6
standard deviation	0.043	1.439	3.2
95% UCL of Mean	0.117	-2.119	8.9

Golder Associates

Table 2: Summary of Historical Acid Sulfate Test Results T0, T2 & T3 Aprons

Test Location	Material Description	pH_{KCl}	sTAA (%S)	S_{NAS} (if pH less than 4.5)	Existing Acidity %S (sTAA + 0.75 x S_{NAS})	Chromium Reducible Sulfur (S_{CR}) %S	Acid Neutralising Capacity %CaCO3 (if pH more than 6.5)	Net Acidity %S (S_{CR}+Existing Acidity - ANC/FF)	Is This AASS	Is This PASS	Liming Rate for Net Acidity (kg/m3)	Liming Rate for Net Acidity Ignoring ANC (kg/m3)
T3 Apron Dredging Area												
SC02-1	Marine Sediment	9.3	< 0.020		0.000	0.11	22.7	-2.314	No	YES	No Additional Lime Required	6.8
SC02-2	Marine Sediment	9.2	< 0.020		0.000	0.13	19.3	-1.931	No	YES	No Additional Lime Required	8.0
SC02-3	Marine Sediment	9.4	< 0.020		0.000	0.08	6.35	-0.598	No	YES	No Additional Lime Required	4.9
SC03-1	Marine Sediment	9.3	< 0.020		0.000	0.11	22.9	-2.336	No	YES	No Additional Lime Required	6.8
SC03-2	Marine Sediment	9.2	< 0.020		0.000	0.03	21.2	-2.234	No	No	NA	NA
SC03-3	Marine Sediment	9.4	< 0.020		0.000	0.05	3.07	-0.278	No	YES	No Additional Lime Required	3.1
SC04-1	Marine Sediment	9.3	< 0.020		0.000	0.122	33	-3.403	No	YES	No Additional Lime Required	7.5
SC04-2	Marine Sediment	9.3	< 0.020		0.000	0.158	32.4	-3.302	No	YES	No Additional Lime Required	9.7
SC04-3	Marine Sediment	9.3	< 0.020		0.000	0.144	11	-1.031	No	YES	No Additional Lime Required	8.8
SC05-1	Marine Sediment	9.3	< 0.020		0.000	0.09	33.4	-3.477	No	YES	No Additional Lime Required	5.5
SC05-2	Marine Sediment	9.2	< 0.020		0.000	0.1	16.9	-1.705	No	YES	No Additional Lime Required	6.1
SC05-3	Marine Sediment	9.4	< 0.020		0.000	0.05	20.4	-2.129	No	YES	No Additional Lime Required	3.1
SC06-1	Marine Sediment	9.4	< 0.020		0.000	0.11	24.9	-2.549	No	YES	No Additional Lime Required	6.8
SC06-2	Marine Sediment	9.3	< 0.020		0.000	0.14	29.8	-3.043	No	YES	No Additional Lime Required	8.6
SC06-3	Marine Sediment	9.4	< 0.020		0.000	0.07	13.8	-1.404	No	YES	No Additional Lime Required	4.3
SC07-1	Marine Sediment	9.4	< 0.020		0.000	0.143	19.7	-1.961	No	YES	No Additional Lime Required	8.8
SC07-2	Marine Sediment	9.3	< 0.020		0.000	0.176	19.8	-1.939	No	YES	No Additional Lime Required	10.8
SC08-1	Marine Sediment	9.4	< 0.020		0.000	0.153	18.5	-1.823	No	YES	No Additional Lime Required	9.4
SC08-2	Marine Sediment	9.4	< 0.020		0.000	0.169	15.4	-1.476	No	YES	No Additional Lime Required	10.4
SC08-3	Marine Sediment	9.4	< 0.020		0.000	0.151	13.6	-1.302	No	YES	No Additional Lime Required	9.3
SC08-4	Marine Sediment	9.4	< 0.020		0.000	0.114	8.13	-0.754	No	YES	No Additional Lime Required	7.0
SC09-1	Marine Sediment	9.4	< 0.020		0.000	0.18	31.4	-3.174	No	YES	No Additional Lime Required	11.1
SC09-2	Marine Sediment	9.3	< 0.020		0.000	0.24	30.2	-2.985	No	YES	No Additional Lime Required	14.7
SC09-3	Marine Sediment	9.3	< 0.020		0.000	0.24	19	-1.789	No	YES	No Additional Lime Required	14.7
SC09-4	Marine Sediment	9.2	< 0.020		0.000	0.25	23.6	-2.271	No	YES	No Additional Lime Required	15.4
SC09-5	Marine Sediment	9.3	< 0.020		0.000	0.25	34.3	-3.413	No	YES	No Additional Lime Required	15.4
SC09-6	Marine Sediment	9.3	< 0.020		0.000	0.18	18.3	-1.775	No	YES	No Additional Lime Required	11.1
SC09-7	Marine Sediment	9.3	< 0.020		0.000	0.23	22	-2.120	No	YES	No Additional Lime Required	14.1
SC09-8	Marine Sediment	9.4	< 0.020		0.000	0.16	40	-4.112	No	YES	No Additional Lime Required	9.8
SC09-9	Marine Sediment	9.4	< 0.020		0.000	0.03	44.1	-4.680	No	No	NA	NA
SC10-1	Marine Sediment	9.3	< 0.020		0.000	0.13	24.1	-2.444	No	YES	No Additional Lime Required	8.0
SC10-2	Marine Sediment	9.3	< 0.020		0.000	0.21	24.4	-2.396	No	YES	No Additional Lime Required	12.9
SC10-3	Marine Sediment	9.3	< 0.020		0.000	0.1	29.9	-3.093	No	YES	No Additional Lime Required	6.1
SC10-4	Marine Sediment	9.4	< 0.020		0.000	0.04	16.7	-1.744	No	YES	No Additional Lime Required	2.5
SC11-1	Marine Sediment	9.4	< 0.020		0.000	0.14	31	-3.171	No	YES	No Additional Lime Required	8.6
SC11-2	Marine Sediment	9.3	< 0.020		0.000	0.19	32	-3.228	No	YES	No Additional Lime Required	11.7
SC11-3	Marine Sediment	9.3	< 0.020		0.000	0.18	36	-3.665	No	YES	No Additional Lime Required	11.1
SC11-4	Marine Sediment	9.3	< 0.020		0.000	0.07	17.3	-1.778	No	YES	No Additional Lime Required	4.3
SC11-5	Marine Sediment	9.4	< 0.020		0.000	0.08	32.9	-3.434	No	YES	No Additional Lime Required	4.9
SC12-1	Marine Sediment	9.3	< 0.020		0.000	0.128	24.7	-2.510	No	YES	No Additional Lime Required	7.9
SC12-2	Marine Sediment	9.3	< 0.020		0.000	0.199	32.9	-3.315	No	YES	No Additional Lime Required	12.2
SC12-3	Marine Sediment	9.3	< 0.020		0.000	0.155	23.9	-2.398	No	YES	No Additional Lime Required	9.5
SC12-4	Marine Sediment	9.4	< 0.020		0.000	0.051	34.8	-3.666	No	YES	No Additional Lime Required	3.1
SC13-1	Marine Sediment	9.4	< 0.020		0.000	0.13	23.8	-2.412	No	YES	No Additional Lime Required	8.0
SC13-2	Marine Sediment	9.4	< 0.020		0.000	0.19	24	-2.373	No	YES	No Additional Lime Required	11.7
SC13-3	Marine Sediment	9.3	< 0.020		0.000	0.13	23.2	-2.348	No	YES	No Additional Lime Required	8.0
SC13-4	Marine Sediment	9.4	< 0.020		0.000	0.13	24.7	-2.508	No	YES	No Additional Lime Required	8.0
SC13-5	Marine Sediment	9.5	< 0.020		0.000	0.06	5.17	-0.492	No	YES	No Additional Lime Required	3.7
SC13-6	Marine Sediment	9.5	< 0.020		0.000	0.04	27.2	-2.865	No	YES	No Additional Lime Required	2.5
SC14-1	Marine Sediment	9.4	< 0.020		0.000	0.103	18.2	-1.841	No	YES	No Additional Lime Required	6.3
SC14-2	Marine Sediment	9.4	< 0.020		0.000	0.189	35.2	-3.570	No	YES	No Additional Lime Required	11.6
SC15-1	Marine Sediment	9.4	< 0.020		0.000	0.126	33.9	-3.495	No	YES	No Additional Lime Required	7.7
SC15-2	Marine Sediment	9.3	< 0.020		0.000	0.134	34.2	-3.519	No	YES	No Additional Lime Required	8.2
SC15-3	Marine Sediment	9.3	< 0.020		0.000	0.072	36.1	-3.784	No	YES	No Additional Lime Required	4.4
SC16-1	Marine Sediment	9.2	< 0.020		0.000	0.118	34.5	-3.567	No	YES	No Additional Lime Required	7.2
SC16-2	Marine Sediment	9.2	< 0.020		0.000	0.182	37.1	-3.780	No	YES	No Additional Lime Required	11.2
SC16-3	Marine Sediment	9.3	< 0.020		0.000	0.13	35.4	-3.651	No	YES	No Additional Lime Required	8.0
SC17-1	Marine Sediment	9.2	< 0.020		0.000	0.134	33.5	-3.444	No	YES	No Additional Lime Required	8.2
SC17-2	Marine Sediment	9.2	< 0.020		0.000	0.105	36.8	-3.825	No	YES	No Additional Lime Required	6.5
SC17-3	Marine Sediment	9.3	< 0.020		0.000	0.085	42.1	-4.411	No	YES	No Additional Lime Required	5.2
SC18-1	Marine Sediment	9.3	< 0.020		0.000	0.141	21	-2.102	No	YES	No Additional Lime Required	8.7
SC18-2	Marine Sediment	9.4	< 0.020		0.000	0.042	31.8	-3.354	No	YES	No Additional Lime Required	2.6
SC18-3	Marine Sediment	9.4	< 0.020		0.000	0.06	33.2	-3.486	No	YES	No Additional Lime Required	3.7
SC18-4	Marine Sediment	9.5	< 0.020		0.000	0.017	33.1	-3.518	No	No	NA	NA
SC18-5	Marine Sediment	9.5	< 0.020		0.000	0.059	47.4	-5.003	No	YES	No Additional Lime Required	3.6
SC18-6	Marine Sediment	9.4	< 0.020		0.000	0.123	33.7	-3.476	No	YES	No Additional Lime Required	7.6
SC19-1	Marine Sediment	10.8	< 0.020		0.000	0.111	32.2	-3.328	No	YES	No Additional Lime Required	6.8
SC19-2	Marine Sediment	9.6	< 0.020		0.000	0.151	30.7	-3.128	No	YES	No Additional Lime Required	9.3
SC19-3	Marine Sediment	9.6	< 0.020		0.000	0.077	34.6	-3.618	No	YES	No Additional Lime Required	4.7
SC20-1	Marine Sediment	9.4	< 0.020		0.000	0.154	19.1	-1.886	No	YES	No Additional Lime Required	9.5
SC20-2	Marine Sediment	9.3	< 0.020		0.000	0.211	28.3	-2.812	No	YES	No Additional Lime Required	13.0
SC20-3	Marine Sediment	9.2	< 0.020		0.000	0.057	13.7	-1.406	No	YES	No Additional Lime Required	3.5
SC20-4	Marine Sediment	9.2	< 0.020		0.000	0.095	16.8	-1.699	No	YES	No Additional Lime Required	5.8
SC20-5	Marine Sediment	9.3	< 0.020		0.000	0.043	34.6	-3.652	No	YES	No Additional Lime Required	2.6
SC20-6	Marine Sediment	9.3	< 0.020		0.000	0.152	47.8	-4.953	No	YES	No Additional Lime Required	9.3
SC21-1	Marine Sediment	9.3	< 0.020		0.000	0.17	29.5	-2.981	No	YES	No Additional Lime Required	10.4
SC21-2	Marine Sediment	9.2	< 0.020		0.000	0.239	28.1	-2.762	No	YES	No Additional Lime Required	14.7
SC21-3	Marine Sediment	9.2	< 0.020		0.000	0.153	20.4	-2.026	No	YES	No Additional Lime Required	9.4
SC21-4	Marine Sediment	9.2	< 0.020		0.000	0.166	24.7	-2.472	No	YES	No Additional Lime Required	10.2
SC21-5	Marine Sediment	9.2	< 0.020		0.000	0.169	31.9	-3.238	No	YES	No Additional Lime Required	10.4
SC21-6	Marine Sediment	9.3	< 0.020		0.000	0.049	57.2	-6.060	No	YES	No Additional Lime Required	3.0
SC22-1	Marine Sediment	9.2	< 0.020		0.000	0.142	27.3	-2.774	No	YES	No Additional Lime Required	8.7
SC22-2	Marine Sediment	9.2	< 0.020		0.000	0.179	28.2	-2.833	No	YES	No Additional Lime Required	11.0
SC22-3	Marine Sediment	9.2	< 0.020		0.000	0.154	16.4	-1.598	No	YES	No Additional Lime Required	9.5
SC22-4	Marine Sediment	9.3	< 0.020		0.000	0.023	20.6	-2.177	No	No	NA	NA
SC23-1	Marine Sediment	9.2	< 0.020		0.000	0.127	21.3	-2.148	No	YES	No Additional Lime Required	7.8
SC23-2	Marine Sediment	9.2	< 0.020		0.000	0.17	18	-1.752	No	YES	No Additional Lime Required	10.4
SC23-3	Marine Sediment	9.1	< 0.020		0.000	0.161	13.6	-1.292	No	YES	No Additional Lime Required	9.9
SC23-4	Marine Sediment	9.3	< 0.020		0.000	0.023	9.49	-0.991	No	No	NA	NA
SC23-5	Marine Sediment	9.4	< 0.020		0.000	0.069	7.54	-0.736	No	YES	No Additional Lime Required	4.2
SC23-6	Marine Sediment	9.3	< 0.020		0.000	0.074	25.8	-2.682	No	YES	No Additional Lime Required	4.5
SC23-7	Marine Sediment	9.3	< 0.020		0.000	0.069	21.1	-2.185	No	YES	No Additional Lime Required	4.2
SC25-1	Marine Sediment	9.2	< 0.020		0.000	0.14	47.9	-4.976	No	YES	No Additional Lime Required	8.6
SC25-2	Marine Sediment	9.2	< 0.020		0.000	0.228	45.1	-4.589	No	YES	No Additional Lime Required	14.0
SC25-3	Marine Sediment	9.2	< 0.020		0.000	0.229	44.9	-4.566	No	YES	No Additional Lime Required	14.1
SC25-4	Marine Sediment	9.2	< 0.020		0.000	0.233	47.2	-4.808	No	YES	No Additional Lime Required	14.3
SC26-1	Marine Sediment	9.3	< 0.020		0.000	0.127	48.8	-5.085	No	YES	No Additional Lime Required	7.8
SC26-2	Marine Sediment	9.3	< 0.020		0.000	0.152	45.7	-4.729	No	YES	No Additional Lime Required	9.3
SC26-3	Marine Sediment	9.3	< 0.020		0.000	0.137	47.6	-4.947	No	YES	No Additional Lime Required	8.4

Table 2: Summary of Historical Acid Sulfate Test Results T0, T2 & T3 Aprons (continue)

Test Location	Material Description	pH_{KCl}	sTAA (%S)	S_{NAS} (if pH less than 4.5)	Existing Acidity %S (sTAA + 0.75 x S_{NAS})	Chromium Reducible Sulfur (S_{CR}) %S	Acid Neutralising Capacity %CaCO3 (if pH more than 6.5)	Net Acidity %S (S_{CR}+Existing Acidity - ANC/FF)	Is This AASS	Is This PASS	Liming Rate for Net Acidity (kg/m3)	Liming Rate for Net Acidity Ignoring ANC (kg/m3)
T2 Apron Dredging Area												
SC01-1	Marine Sediment	9.3	< 0.020		0.000	0.146	22.6	-2.268	No	YES	No Additional Lime Required	9.0
SC01-2	Marine Sediment	9.2	< 0.020		0.000	0.128	8.72	-0.803	No	YES	No Additional Lime Required	7.9
SC01-3	Marine Sediment	9.1	< 0.020		0.000	0.116	3.18	-0.224	No	YES	No Additional Lime Required	7.1
SC01-4	Marine Sediment	9.3	< 0.020		0.000	0.022	1.58	-0.147	No	No	NA	NA
SC24-1	Marine Sediment	9.2	< 0.020		0.000	0.198	24.7	-2.440	No	YES	No Additional Lime Required	12.2
SC24-2	Marine Sediment	9.3	< 0.020		0.000	0.285	23.1	-2.182	No	YES	No Additional Lime Required	17.5
SC24-3	Marine Sediment	9.1	< 0.020		0.000	0.069	5.87	-0.558	No	YES	No Additional Lime Required	4.2
SC24-4	Marine Sediment	9.3	< 0.020		0.000	0.04	1.93	-0.166	No	YES	No Additional Lime Required	2.5
SC24-5	Marine Sediment	9.3	< 0.020		0.000	0.054	0.94	-0.046	No	YES	No Additional Lime Required	3.3
SC24-6	Marine Sediment	9.3	< 0.020		0.000	0.032	25	-2.638	No	YES	No Additional Lime Required	2.0
SC27-1	Marine Sediment	9.2	< 0.020		0.000	0.118	23.8	-2.424	No	YES	No Additional Lime Required	7.2
SC27-2	Marine Sediment	9.2	< 0.020		0.000	0.148	22.1	-2.212	No	YES	No Additional Lime Required	9.1
SC27-3	Marine Sediment	9.3	< 0.020		0.000	0.049	18.3	-1.906	No	YES	No Additional Lime Required	3.0
SC27-4	Marine Sediment	9.3	< 0.020		0.000	0.093	2.9	-0.217	No	YES	No Additional Lime Required	5.7
SC27-5	Marine Sediment	9.4	< 0.020		0.000	0.089	3.69	-0.305	No	YES	No Additional Lime Required	5.5
SC28-1	Marine Sediment	9.3	< 0.020		0.000	0.097	24.4	-2.509	No	YES	No Additional Lime Required	6.0
SC28-2	Marine Sediment	9.2	< 0.020		0.000	0.107	11.3	-1.100	No	YES	No Additional Lime Required	6.6
SC28-3	Marine Sediment	9.3	< 0.020		0.000	0.118	11.4	-1.100	No	YES	No Additional Lime Required	7.2
SC29-1	Marine Sediment	9.4	< 0.020		0.000	0.114	30.4	-3.133	No	YES	No Additional Lime Required	7.0
SC29-2	Marine Sediment	9.4	< 0.020		0.000	0.195	21.2	-2.069	No	YES	No Additional Lime Required	12.0
SC29-3	Marine Sediment	9.3	< 0.020		0.000	0.038	8.79	-0.901	No	YES	No Additional Lime Required	2.3
SC29-4	Marine Sediment	9.4	< 0.020		0.000	0.038	1.15	-0.085	No	YES	No Additional Lime Required	2.3
SC29-5	Marine Sediment	9.5	< 0.020		0.000	0.073	2.05	-0.146	No	YES	No Additional Lime Required	4.5
SC29-6	Marine Sediment	9.4	< 0.020		0.000	0.088	7.88	-0.754	No	YES	No Additional Lime Required	5.4
SC30-1	Marine Sediment	9.4	< 0.020		0.000	0.114	29.2	-3.005	No	YES	No Additional Lime Required	7.0
SC30-2	Marine Sediment	9.3	< 0.020		0.000	0.176	14.1	-1.330	No	YES	No Additional Lime Required	10.8
SC30-3	Marine Sediment	9.3	< 0.020		0.000	0.173	16.5	-1.589	No	YES	No Additional Lime Required	10.6
SC30-4	Marine Sediment	9.4	< 0.020		0.000	0.186	29.4	-2.954	No	YES	No Additional Lime Required	11.4
SC31-1	Marine Sediment	9.4	< 0.020		0.000	0.094	23.7	-2.437	No	YES	No Additional Lime Required	5.8
SC31-2	Marine Sediment	9.3	< 0.020		0.000	0.2	20.6	-2.000	No	YES	No Additional Lime Required	12.3
SC31-3	Marine Sediment	9.1	< 0.020		0.000	0.295	7.4	-0.495	No	YES	No Additional Lime Required	18.1
SC31-4	Marine Sediment	9.2	< 0.020		0.000	0.198	33.3	-3.359	No	YES	No Additional Lime Required	12.2
SC32-1	Marine Sediment	9.4	< 0.020		0.000	0.128	29.7	-3.044	No	YES	No Additional Lime Required	7.9
SC32-2	Marine Sediment	9.4	< 0.020		0.000	0.229	22.3	-2.153	No	YES	No Additional Lime Required	14.1
SC32-3	Marine Sediment	9.3	< 0.020		0.000	0.189	19.9	-1.936	No	YES	No Additional Lime Required	11.6
SC32-4	Marine Sediment	9.5	< 0.020		0.000	0.069	34.3	-3.594	No	YES	No Additional Lime Required	4.2
SC33-1	Marine Sediment	9.4	< 0.020		0.000	0.134	29.3	-2.995	No	YES	No Additional Lime Required	8.2
SC33-2	Marine Sediment	9.4	< 0.020		0.000	0.138	29	-2.959	No	YES	No Additional Lime Required	8.5
SC33-3	Marine Sediment	9.4	< 0.020		0.000	0.051	40.9	-4.317	No	YES	No Additional Lime Required	3.1
SC34-1	Marine Sediment	9.4	< 0.020		0.000	0.174	28.5	-2.870	No	YES	No Additional Lime Required	10.7
SC34-2	Marine Sediment	9.4	< 0.020		0.000	0.166	33.9	-3.455	No	YES	No Additional Lime Required	10.2
SC34-3	Marine Sediment	9.4	< 0.020		0.000	0.045	38.9	-4.110	No	YES	No Additional Lime Required	2.8
SC35-1	Marine Sediment	9.4	< 0.020		0.000	0.15	30	-3.054	No	YES	No Additional Lime Required	9.2
SC35-2	Marine Sediment	9.4	< 0.020		0.000	0.256	23.1	-2.211	No	YES	No Additional Lime Required	15.7
SC35-3	Marine Sediment	9.5	< 0.020		0.000	0.157	34.2	-3.496	No	YES	No Additional Lime Required	9.6
SC35-4	Marine Sediment	9.6	< 0.020		0.000	0.068	43.1	-4.535	No	YES	No Additional Lime Required	4.2
SC36-1	Marine Sediment	9.4	< 0.020		0.000	0.159	23.2	-2.319	No	YES	No Additional Lime Required	9.8
SC36-2	Marine Sediment	9.4	< 0.020		0.000	0.222	23.2	-2.256	No	YES	No Additional Lime Required	13.6
SC36-3	Marine Sediment	9.4	< 0.020		0.000	0.153	31.1	-3.169	No	YES	No Additional Lime Required	9.4
SC36-4	Marine Sediment	9.5	< 0.020		0.000	0.087	43.3	-4.538	No	YES	No Additional Lime Required	5.3
SC37-1	Marine Sediment	9.3	< 0.020		0.000	0.234	23.1	-2.233	No	YES	No Additional Lime Required	14.4
SC37-2	Marine Sediment	9.3	< 0.020		0.000	0.226	23.1	-2.241	No	YES	No Additional Lime Required	13.9
SC37-3	Marine Sediment	9.2	< 0.020		0.000	0.135	18.2	-1.809	No	YES	No Additional Lime Required	8.3
SC40-1	Marine Sediment	9.4	< 0.020		0.000	0.096	23.5	-2.414	No	YES	No Additional Lime Required	5.9
SC40-2	Marine Sediment	9.3	< 0.020		0.000	0.153	23.5	-2.357	No	YES	No Additional Lime Required	9.4
SC40-3	Marine Sediment	9.2	< 0.020		0.000	0.146	30.6	-3.122	No	YES	No Additional Lime Required	9.0
SC42-1	Marine Sediment	9.3	< 0.020		0.000	0.164	22.3	-2.218	No	YES	No Additional Lime Required	10.1
SC42-2	Marine Sediment	9.2	< 0.020		0.000	0.264	21.8	-2.064	No	YES	No Additional Lime Required	16.2
SC43-1	Marine Sediment	9.4	< 0.020		0.000	0.109	23.3	-2.380	No	YES	No Additional Lime Required	6.7
SC43-2	Marine Sediment	9.3	< 0.020		0.000	0.229	23.4	-2.270	No	YES	No Additional Lime Required	14.1
SC43-3	Marine Sediment	9.2	< 0.020		0.000	0.253	23.1	-2.214	No	YES	No Additional Lime Required	15.5
SC44-1	Marine Sediment	9.3	< 0.020		0.000	0.123	33.6	-3.466	No	YES	No Additional Lime Required	7.6
SC44-2	Marine Sediment	9.2	< 0.020		0.000	0.23	32.8	-3.273	No	YES	No Additional Lime Required	14.1
SC44-3	Marine Sediment	9.3	< 0.020		0.000	0.053	55.1	-5.832	No	YES	No Additional Lime Required	3.3
SC46-1	Marine Sediment	9.4	< 0.020		0.000	0.096	34.5	-3.589	No	YES	No Additional Lime Required	5.9
SC46-2	Marine Sediment	9.3	< 0.020		0.000	0.141	32	-3.277	No	YES	No Additional Lime Required	8.7
SC46-3	Marine Sediment	9.3	< 0.020		0.000	0.199	21.7	-2.119	No	YES	No Additional Lime Required	12.2
SC47-1	Marine Sediment	9.3	< 0.020		0.000	0.139	23.1	-2.328	No	YES	No Additional Lime Required	8.5
SC47-2	Marine Sediment	9.2	< 0.020		0.000	0.28	22.2	-2.091	No	YES	No Additional Lime Required	17.2
SC47-3	Marine Sediment	9.1	< 0.020		0.000	0.309	16.8	-1.485	No	YES	No Additional Lime Required	19.0
SC48-1	Marine Sediment	9.4	< 0.020		0.000	0.097	23.4	-2.402	No	YES	No Additional Lime Required	6.0
SC48-2	Marine Sediment	9.2	< 0.020		0.000	0.257	21.5	-2.039	No	YES	No Additional Lime Required	15.8
SC48-3	Marine Sediment	9.1	< 0.020		0.000	0.276	10.5	-0.845	No	YES	No Additional Lime Required	17.0
SC49-1	Marine Sediment	9.4	< 0.020		0.000	0.101	32.9	-3.413	No	YES	No Additional Lime Required	6.2
SC49-2	Marine Sediment	9.4	< 0.020		0.000	0.143	33.2	-3.403	No	YES	No Additional Lime Required	8.8
SC50-1	Marine Sediment	9.5	< 0.020		0.000	0.087	32.7	-3.405	No	YES	No Additional Lime Required	5.3
SC50-2	Marine Sediment	9.3	< 0.020		0.000	0.186	34.2	-3.467	No	YES	No Additional Lime Required	11.4
SC51-1	Marine Sediment	9.3	< 0.020		0.000	0.119	33.8	-3.491	No	YES	No Additional Lime Required	7.3
SC51-2	Marine Sediment	9.2	< 0.020		0.000	0.217	33.6	-3.372	No	YES	No Additional Lime Required	13.3
SC52-1	Marine Sediment	9.4	< 0.020		0.000	0.083	45.1	-4.734	No	YES	No Additional Lime Required	5.1
SC52-2	Marine Sediment	9.3	< 0.020		0.000	0.151	47	-4.869	No	YES	No Additional Lime Required	9.3
SC53-1	Marine Sediment	9.3	< 0.020		0.000	0.104	34.2	-3.549	No	YES	No Additional Lime Required	6.4
SC54-1	Marine Sediment	9.4	< 0.020		0.000	0.089	34.8	-3.628	No	YES	No Additional Lime Required	5.5
SC54-2	Marine Sediment	9.3	< 0.020		0.000	0.174	33.4	-3.393	No	YES	No Additional Lime Required	10.7
SC55-1	Marine Sediment	9.3	< 0.020		0.000	0.081	26.2	-2.717	No	YES	No Additional Lime Required	5.0
SC57-1	Marine Sediment	9.4	< 0.020		0.000	0.171	21.2	-2.093	No	YES	No Additional Lime Required	10.5
SC57-2	Marine Sediment	9	< 0.020		0.000	0.285	3.96	-0.138	No	YES	No Additional Lime Required	17.5

Table 2: Summary of Historical Acid Sulfate Test Results T0, T2 & T3 Aprons (continue)

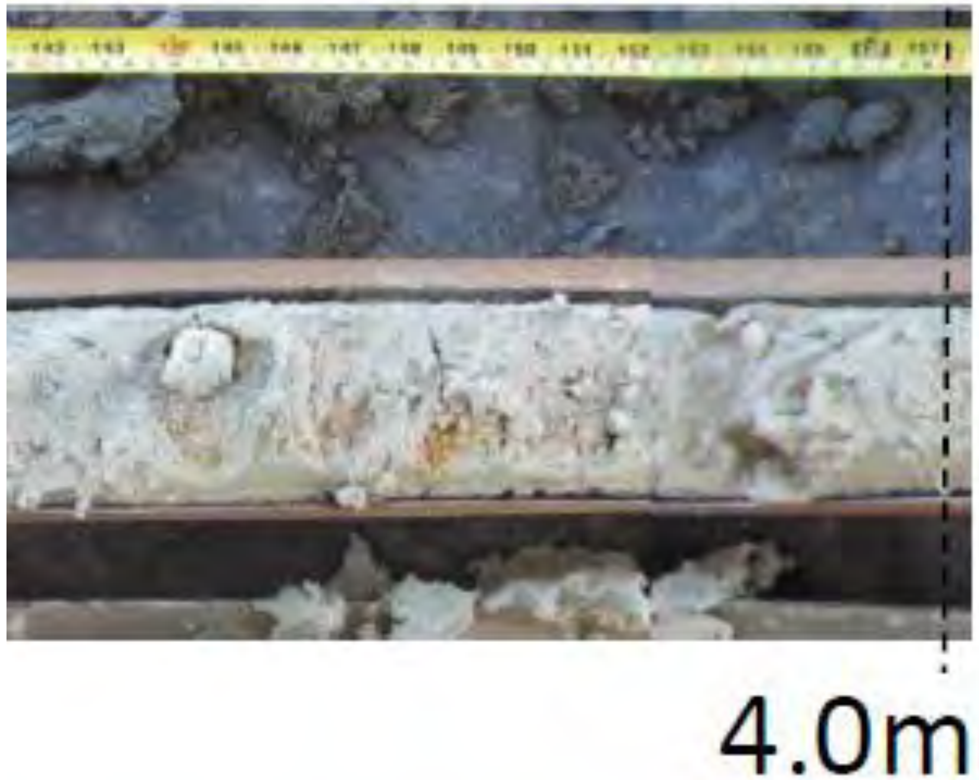
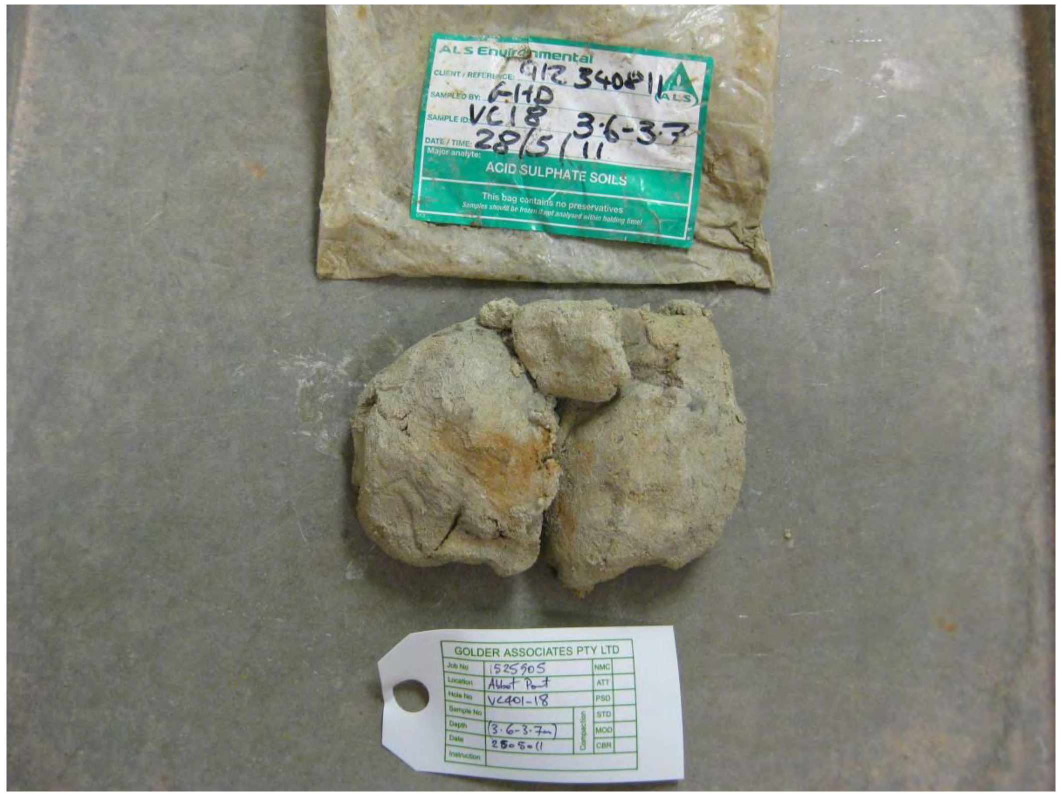
Test Location	Material Description	pH_{KCl}	sTAA (%S)	S_{NAS} (if pH less than 4.5)	Existing Acidity %S (sTAA + 0.75 x S_{NAS})	Chromium Reducible Sulfur (S_{CR}) %S	Acid Neutralising Capacity %CaCO3 (if pH more than 6.5)	Net Acidity %S (S_{CR}+Existing Acidity - ANC/FF)	Is This AASS	Is This PASS	Liming Rate for Net Acidity (kg/m3)	Liming Rate for Net Acidity Ignoring ANC (kg/m3)
T0 Apron Dredging Area												
SC58-1	Marine Sediment	9.2	< 0.020		0.000	0.142	23.1	-2.325	No	YES	No Additional Lime Required	8.7
SC58-2	Marine Sediment	9.3	< 0.020		0.000	0.195	29.8	-2.988	No	YES	No Additional Lime Required	12.0
SC58-3	Marine Sediment	9.2	< 0.020		0.000	0.231	29.4	-2.909	No	YES	No Additional Lime Required	14.2
SC59-1	Marine Sediment	9.4	< 0.020		0.000	0.091	30.6	-3.177	No	YES	No Additional Lime Required	5.6
SC59-2	Marine Sediment	9.4	< 0.020		0.000	0.144	30	-3.060	No	YES	No Additional Lime Required	8.8
SC59-3	Marine Sediment	9.3	< 0.020		0.000	0.209	29.2	-2.910	No	YES	No Additional Lime Required	12.8
SC59-4	Marine Sediment	9.3	< 0.020		0.000	0.266	22.4	-2.126	No	YES	No Additional Lime Required	16.3
SC59-5	Marine Sediment	9.1	< 0.020		0.000	0.262	17.6	-1.618	No	YES	No Additional Lime Required	16.1
SC60-1	Marine Sediment	9.4	< 0.020		0.000	0.068	31.3	-3.275	No	YES	No Additional Lime Required	4.2
SC60-2	Marine Sediment	9.3	< 0.020		0.000	0.188	31.6	-3.187	No	YES	No Additional Lime Required	11.6
SC60-3	Marine Sediment	9.1	< 0.020		0.000	0.200	21.7	-2.118	No	YES	No Additional Lime Required	12.3
SC61-1	Marine Sediment	9.4	< 0.020		0.000	0.126	31.8	-3.270	No	YES	No Additional Lime Required	7.7
SC61-2	Marine Sediment	9.2	< 0.020		0.000	0.200	21.7	-2.118	No	YES	No Additional Lime Required	12.3
SC62-1	Marine Sediment	9.4	< 0.020		0.000	0.080	33.4	-3.487	No	YES	No Additional Lime Required	4.9
SC62-2	Marine Sediment	9.3	< 0.020		0.000	0.141	33.6	-3.448	No	YES	No Additional Lime Required	8.7
SC62-3	Marine Sediment	9.2	< 0.020		0.000	0.210	23	-2.246	No	YES	No Additional Lime Required	12.9
SC63-1	Marine Sediment	9.3	< 0.020		0.000	0.190	32.3	-3.260	No	YES	No Additional Lime Required	11.7
SC63-2	Marine Sediment	9.4	< 0.020		0.000	0.108	33.2	-3.438	No	YES	No Additional Lime Required	6.6
SC64-1	Marine Sediment	9.4	< 0.020		0.000	0.069	34.1	-3.573	No	YES	No Additional Lime Required	4.2
SC64-2	Marine Sediment	9.3	< 0.020		0.000	0.191	33.3	-3.366	No	YES	No Additional Lime Required	11.7
SC65-1	Marine Sediment	8.9	< 0.020		0.000	0.226	7.04	-0.526	No	YES	No Additional Lime Required	13.9
SC66-1	Marine Sediment	9.1	< 0.020		0.000	0.088	10.4	-1.023	No	YES	No Additional Lime Required	5.4
SC67-1	Marine Sediment	9.4	< 0.020		0.000	0.104	29.5	-3.047	No	YES	No Additional Lime Required	6.4
SC67-2	Marine Sediment	9.3	< 0.020		0.000	0.166	29.5	-2.985	No	YES	No Additional Lime Required	10.2
SC67-3	Marine Sediment	9.3	< 0.020		0.000	0.202	23.4	-2.297	No	YES	No Additional Lime Required	12.4
SC67-4	Marine Sediment	9.1	< 0.020		0.000	0.268	18.3	-1.687	No	YES	No Additional Lime Required	16.5
SC67-5	Marine Sediment	9.1	< 0.020		0.000	0.170	20.7	-2.041	No	YES	No Additional Lime Required	10.4
SC68-1	Marine Sediment	9.5	< 0.020		0.000	0.071	30.1	-3.144	No	YES	No Additional Lime Required	4.4
SC68-2	Marine Sediment	9.4	< 0.020		0.000	0.156	30	-3.048	No	YES	No Additional Lime Required	9.6
SC68-3	Marine Sediment	9.1	< 0.020		0.000	0.469	16.3	-1.272	No	YES	No Additional Lime Required	28.8
SC68-4	Marine Sediment	9	< 0.020		0.000	0.529	1.86	0.330	No	YES	20.3	32.5
SC69-1	Marine Sediment	9.4	< 0.020		0.000	0.076	27.6	-2.872	No	YES	No Additional Lime Required	4.7
SC69-2	Marine Sediment	9.4	< 0.020		0.000	0.169	29.2	-2.950	No	YES	No Additional Lime Required	10.4
SC69-3	Marine Sediment	9.3	< 0.020		0.000	0.216	23.1	-2.251	No	YES	No Additional Lime Required	13.3
SC69-4	Marine Sediment	9.1	< 0.020		0.000	0.273	14.8	-1.308	No	YES	No Additional Lime Required	16.8
SC69-5	Marine Sediment	8.9	< 0.020		0.000	0.270	3.69	-0.124	No	YES	No Additional Lime Required	16.6

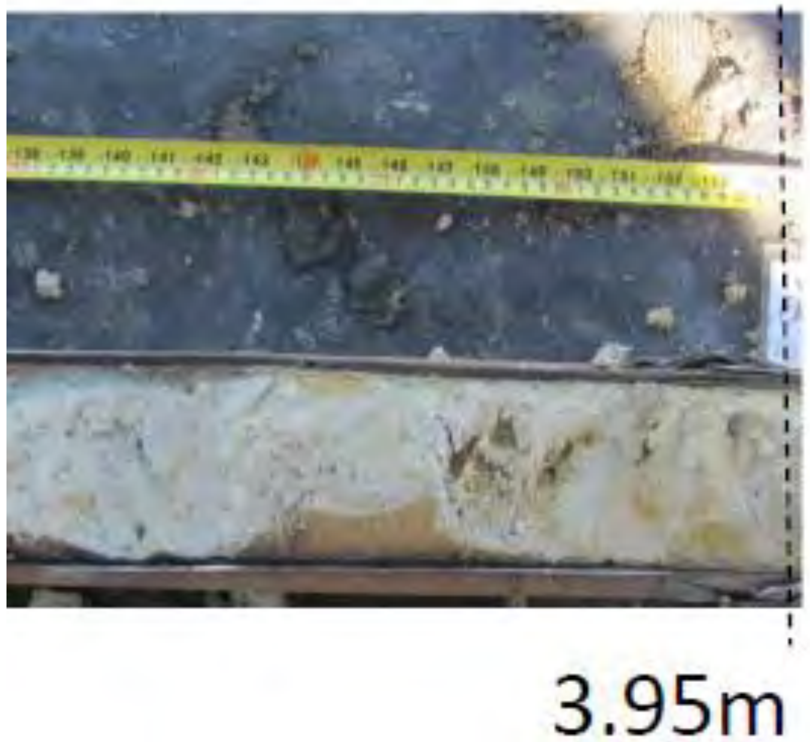
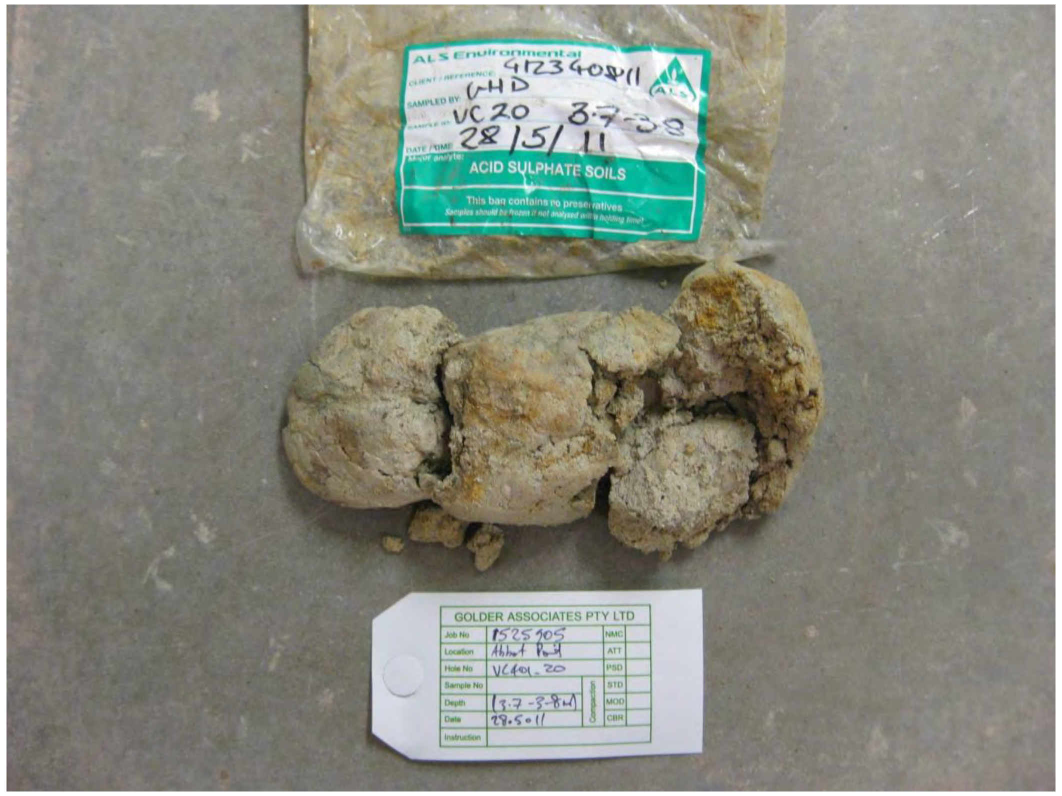
Input By: SB
Date 27/7/15
Checked: PS
Date 27/7/15

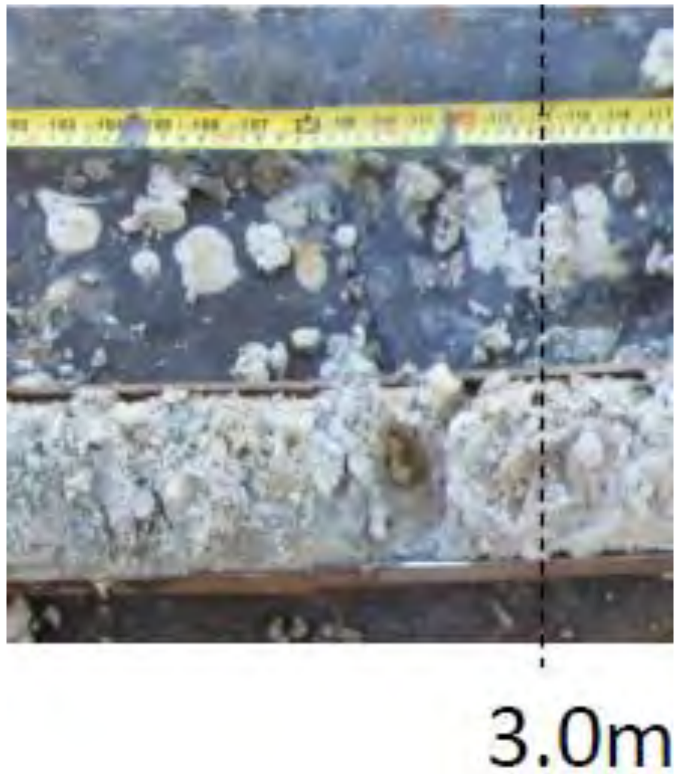
Note: * Equivalent oxidisable sulfur calculated as TAA/30.59
Liming rates assume a bulk density of 1.30 t/m3
Fineness Factor = 3

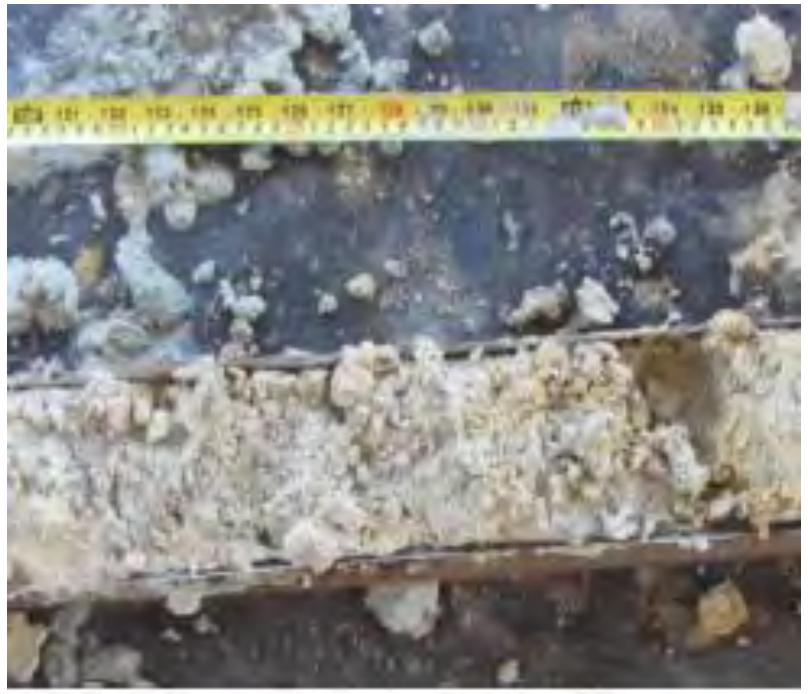
Statistical Summary	Chromium Reducible Sulfur (%S)	Net Acidity (%S)	Lime Treatment Rate excluding ANC (kg lime/m3)
Marine Sediment Summary T0 only			
Sample count	36	36	36
Average concentration	0.188	-2.448	11.5
minimum concentration	0.068	-3.573	4.2
maximum concentration	0.529	0.330	32.5
standard deviation	0.099	0.995	6.1
95% UCL of Mean	0.220	-2.123	13.5
Marine Sediment Summary T2 only			
Sample count	87	87	86
Average concentration	0.146	-2.394	9.0
minimum concentration	0.022	-5.832	2.0
maximum concentration	0.309	-0.046	19.0
standard deviation	0.070	1.239	4.3
95% UCL of Mean	0.160	-2.133	9.9
Marine Sediment Summary T3 only			
Sample count	99	99	94
Average concentration	0.129	-2.807	8.3
minimum concentration	0.017	-6.060	2.5
maximum concentration	0.250	-0.278	15.4
standard deviation	0.059	1.161	3.4
95% UCL of Mean	0.140	-2.578	8.9
Marine Sediment Summary T0, T2 and T3			
Sample count	222	222	216
Average concentration	0.145	-2.587	9.1
minimum concentration	0.017	-6.060	2.0
maximum concentration	0.529	0.330	32.5
standard deviation	0.074	1.180	4.4
95% UCL of Mean	0.155	-2.432	9.7

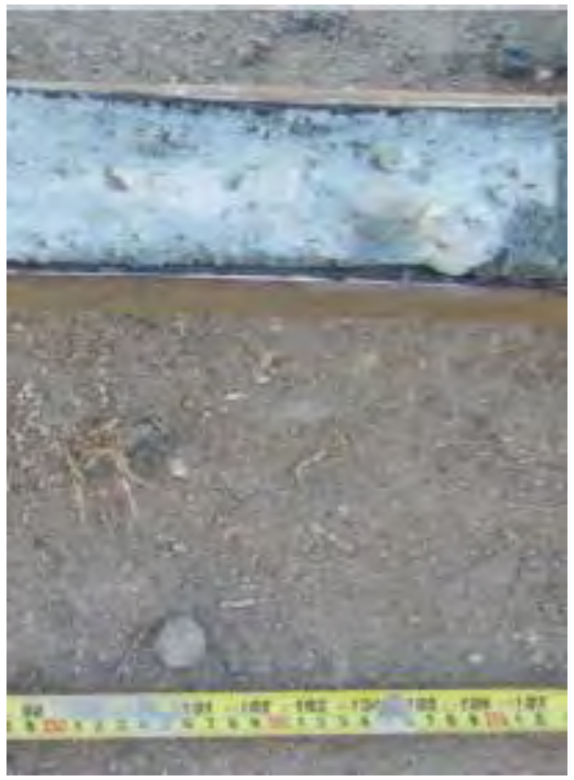
Attachment 1 – Sample Photographs

Sample Location	Material Type	Observations	Photographs	
			GHD 2011	Golder 2015
VC401_18 (1.7-1.8 m)	Marine Sediment	Minor iron staining near edge of sample where air may have entered degraded bag. Sample still relatively moist.		
VC401_18 (3.6-3.7 m)	Alluvium/Residual Soil	Similar appearance to 2011 photo, but slightly drier.		

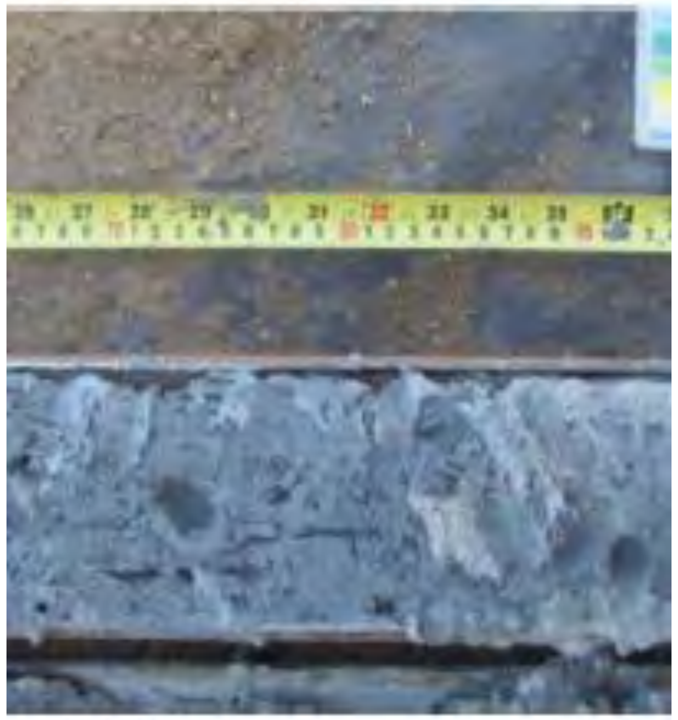
Sample Location	Material Type	Observations	Photographs	
			GHD 2011	Golder 2015
VC401_18 (4.5-4.9 m)	Alluvium/Residual Soil	Similar appearance to 2011 photo, but drier.		
VC401_20 (3.7-3.8 m)	Alluvium/Residual Soil	Similar appearance to 2011 photo, but drier.		

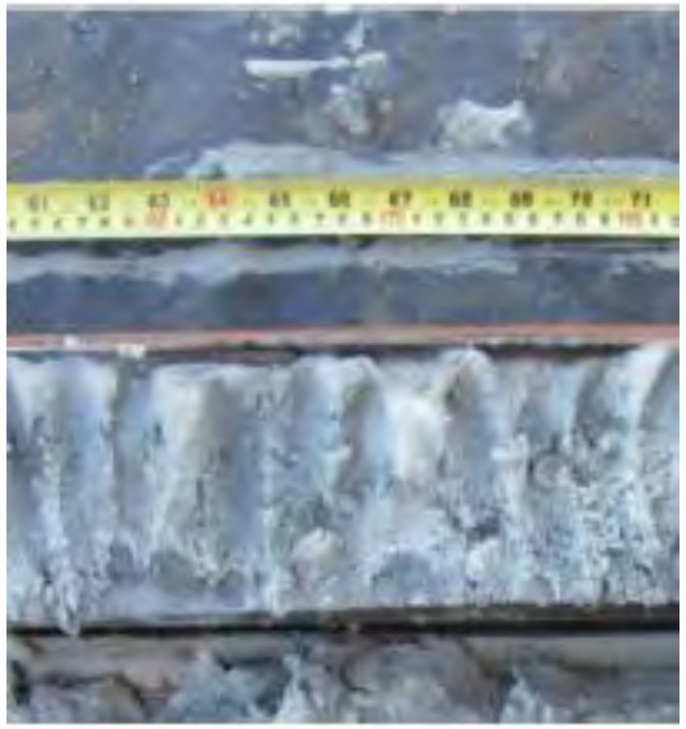
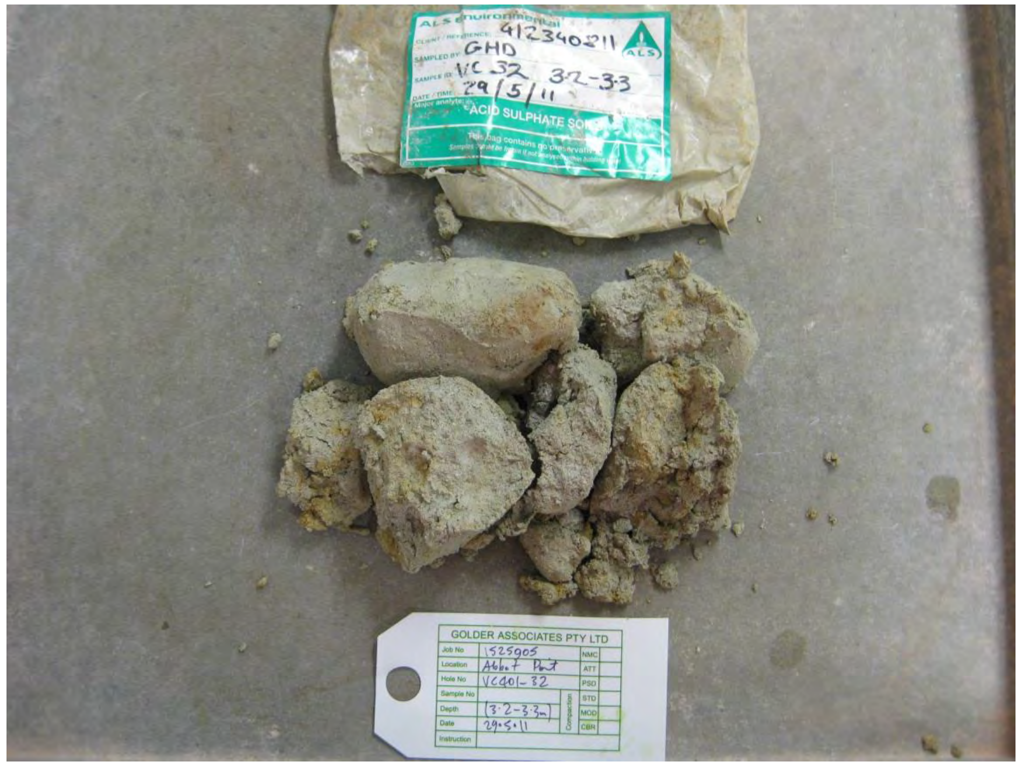
Sample Location	Material Type	Observations	Photographs	
			GHD 2011	Golder 2015
VC401_22 (1.6-1.7 m)	Marine Sediment	Minor iron staining. Sample still relatively moist.		
VC401_22 (2.7-2.9 m)	Alluvium/Residual Soil	Similar appearance to 2011 photo, but drier.		

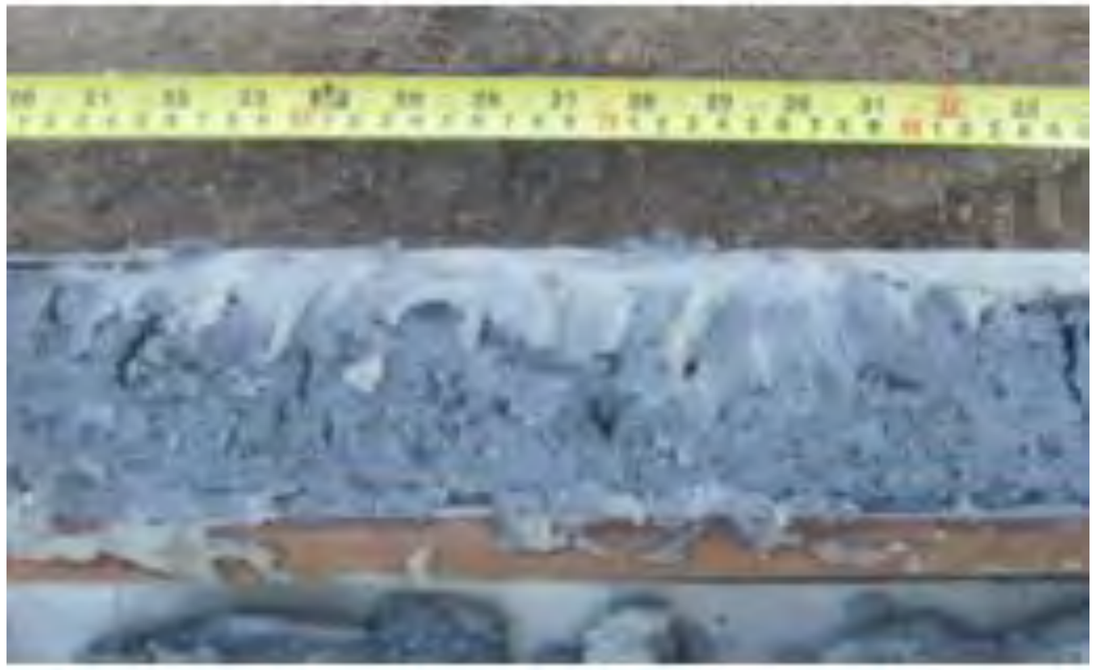
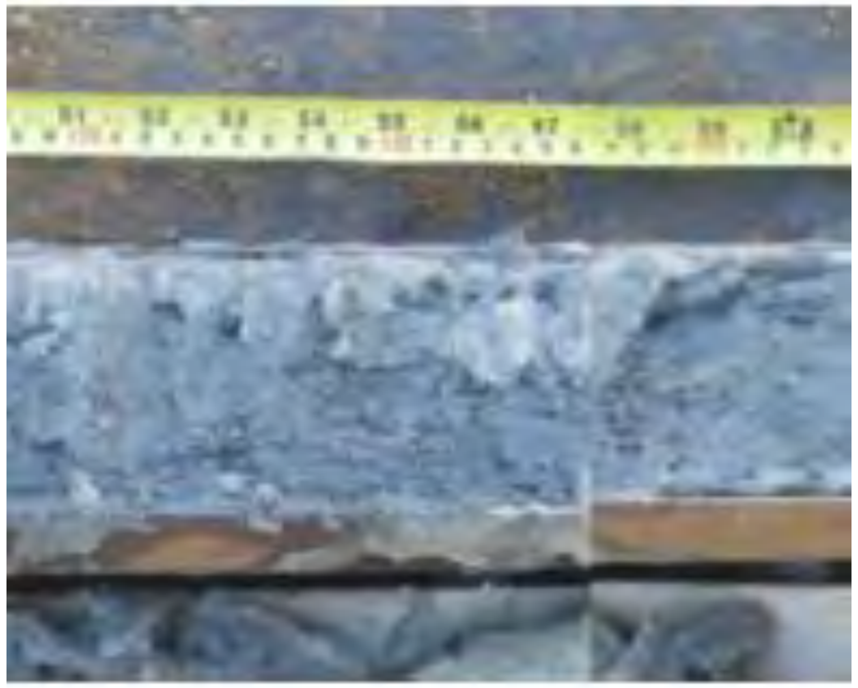
Sample Location	Material Type	Observations	Photographs	
			GHD 2011	**Golder 2015**
VC401_22 (3.5-3.9 m)	Alluvium/Residual Soil	Similar appearance to 2011 photo, but drier.		
VC401_23B (0.2-0.3 m)	Marine Sediment	Moderate iron staining. Sample remains relatively moist.		

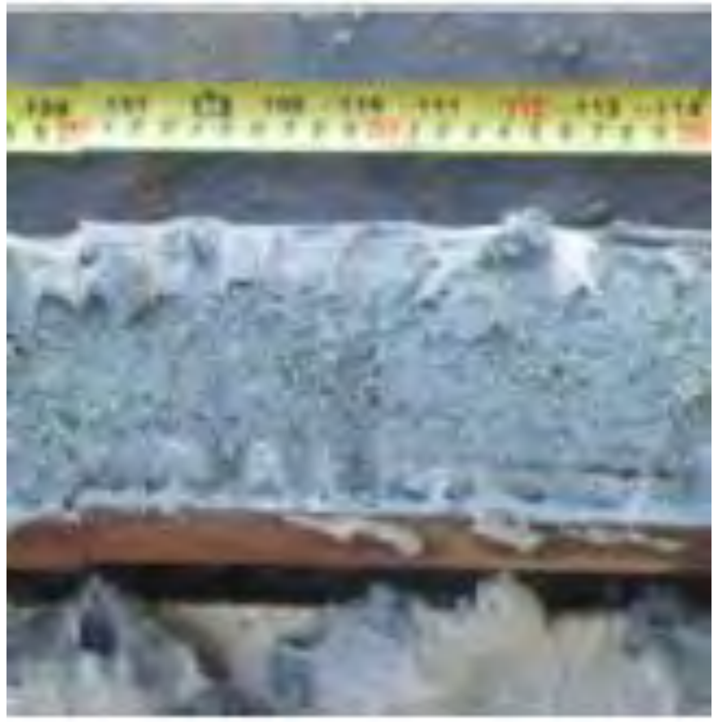
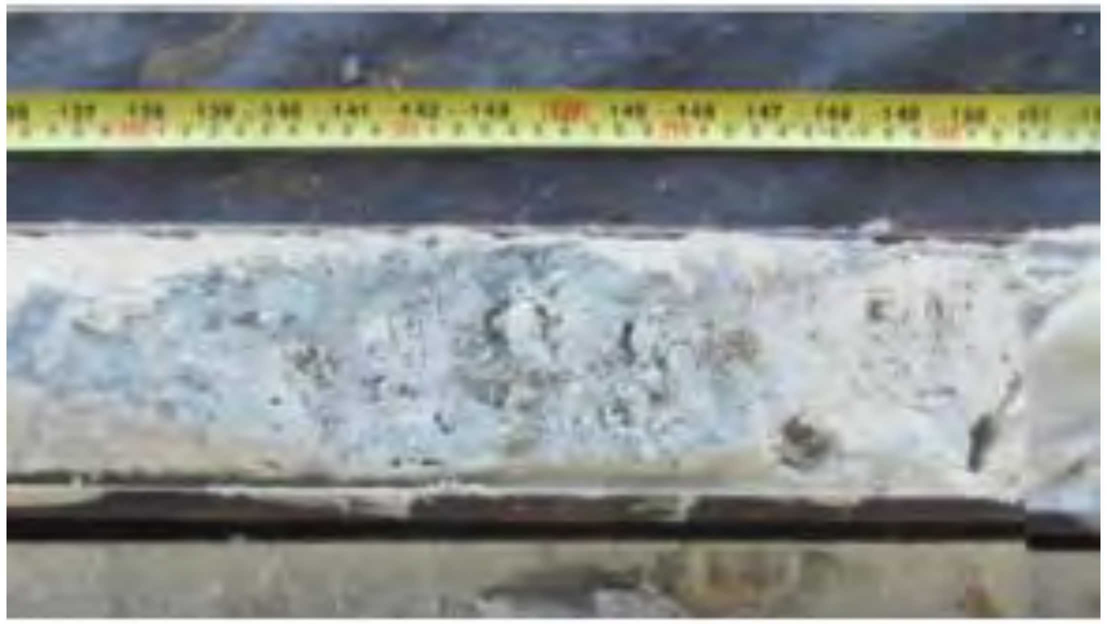
Sample Location	Material Type	Observations	Photographs	
			GHD 2011	Golder 2015
VC401_23B (2.1-2.4 m)	Alluvium/Residual Soil	Some iron staining		
VC401_23B (2.8-2.9 m)	Alluvium/Residual Soil	Significant drying, some iron staining		

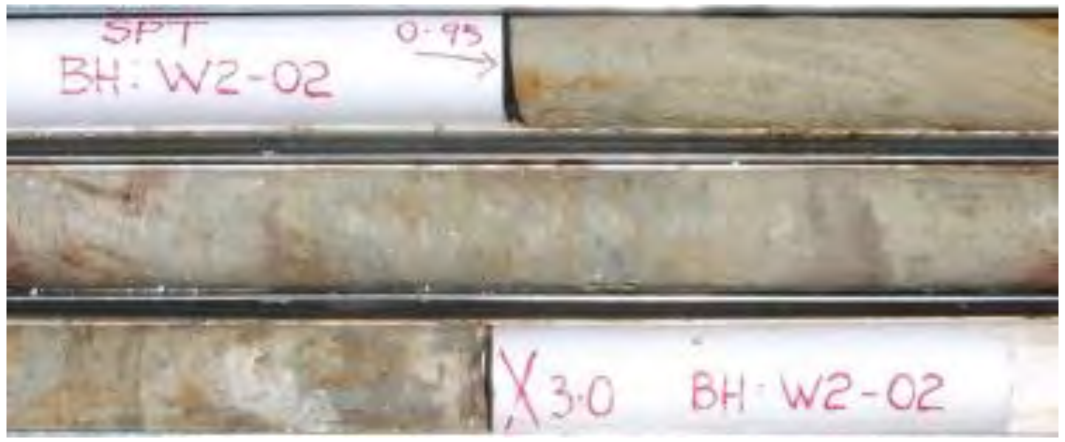
Sample Location	Material Type	Observations	Photographs	
			GHD 2011	Golder 2015
VC401_31A (0.6-0.7 m)	Marine Sediment	Minor iron staining. Sample bag had deteriorated allowing outer surface of sample to dry and oxidise. Centre of sample remains moist.		
VC401_31A (1.6-1.7 m)	Alluvium/Residual Soil	Significant drying, some iron staining		

Sample Location	Material Type	Observations	Photographs	
			GHD 2011	Golder 2015
VC401_31A (4.2-4.3 m)	Alluvium/Residual Soil	Similar appearance to 2011 photo, but drier.		
VC401_32 (0.7-0.8 m)	Marine Sediment	Minor iron staining. Sample remains relatively moist.		

<table>
<tr><th rowspan="2">Sample Location</th><th rowspan="2">Material Type</th><th rowspan="2">Observations</th><th colspan="2">Photographs</th></tr>
<tr><th>GHD 2011</th><th>Golder 2015</th></tr>
<tr><td>VC401_32 (1.6-1.7 m)</td><td>Marine Sediment</td><td>Sample has dried. Slight iron staining present.</td><td></td><td>
</td></tr>
<tr><td>VC401_32 (3.2-3.3 m)</td><td>Alluvium/Residual Soil</td><td>Similar appearance to 2011 photo, but drier. Slight iron staining.</td><td></td><td>
</td></tr>
</table>

Sample Location	Material Type	Observations	Photographs	
			GHD 2011	Golder 2015
VC401_33 (0.5-0.9 m)	Marine Sediment	Sample is much drier than 2011. Iron staining and shells present.		
VC401_33 (1.7-1.8 m)	Marine Sediment	Sample drier. Iron staining in corner where bag had deteriorated.		

Sample Location	Material Type	Observations	Photographs	
			GHD 2011	Golder 2015
VC401_33 (2.7-2.8 m)	Marine Sediment	Very slight iron staining		
VC401_33 (3.5-3.9 m)	Marine Sediment	Similar appearance to 2011 photo, but drier.		

Sample Location	Material Type	Observations	Photographs	
			GHD 2011	Golder 2015
BHW2-02 (0.95-0.99 m)	Alluvium/Residual Soil	Stiff mottled clayey sand/sandy clay		
BHW2-03 (0.95-1.00 m)	Alluvium/Residual Soil	Stiff mottled clayey sand/sandy clay	No Photo	

Sample Location	Material Type	Observations	Photographs	
			GHD 2011	Golder 2015
BHW2-09 (1.06-1.10 m)	Marine Sediment	Faint iron staining.	No Photo	

Attachment 2 – Laboratory Certificates

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1523405**	Page	: 1 of 6
Client	: **GOLDER ASSOCIATES**	Laboratory	: Environmental Division Brisbane
Contact	: MR PAUL SCELLS	Contact	: Augustin Raj
Address	: P O BOX 1734 MILTON QLD, AUSTRALIA 4064	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: pscells@golder.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: 4724 0311	Telephone	: +61-7-3243 7222
Facsimile	: ----	Facsimile	: +61-7-3243 7218
Project	: 1525905-500-507	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: Q002109	Date Samples Received	: 17-Jul-2015 05:00
C-O-C number	: ----	Date Analysis Commenced	: 22-Jul-2015
Sampler	: ----	Issue Date	: 22-Jul-2015 13:09
Site	: ----		
		No. of samples received	: 20
Quote number	: ----	No. of samples analysed	: 20

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Satishkumar Trivedi	Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- ASS: EA033 (CRS Suite):Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.

Work Order : EB1523405
Client : GOLDER ASSOCIATES
Project : 1525905-500-507

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	VC401_18(1.7-1.8m)	VC401_18(3.6-3.7m)	VC401_18(4.5-4.9m)	VC401_20(3.7-3.8m)	VC401_22(1.6-1.7m)
			Client sampling date / time	[28-May-2015]	[28-May-2015]	[28-May-2015]	[28-May-2015]	[29-May-2015]
Compound	CAS Number	LOR	Unit	EB1523405-001	EB1523405-002	EB1523405-003	EB1523405-004	EB1523405-005
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	9.1	9.3	9.1	9.3	9.1
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	0.153	<0.005	0.005	<0.005	0.116
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	95	<10	<10	<10	72
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	24.3	42.8	34.7	45.2	1.36
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	4850	8550	6940	9020	271
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	7.78	13.7	11.1	14.5	0.44
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	VC401_22(2.7-2.9m)	VC401_22(3.5-3.9m)	VC401_23B(0.2-0.3m)	VC401_23B(2.1-2.4m)	VC401_31A(0.6-0.7m)
			Client sampling date / time	[29-May-2015]	[29-May-2015]	[29-May-2015]	[29-May-2015]	[29-May-2015]
Compound	CAS Number	LOR	Unit	EB1523405-006	EB1523405-007	EB1523405-008	EB1523405-009	EB1523405-010
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	9.3	9.3	9.4	9.4	9.1
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	0.047	0.008	0.119
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	29	<10	74
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	36.4	40.8	29.7	27.2	16.5
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	7260	8150	5940	5430	3300
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	11.6	13.1	9.52	8.71	5.29
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	VC401_31A(1.6-1.7m)	VC401_32(0.7-0.8m)	VC401_32(1.6-1.7m)	VC401_32(3.2-3.3m)	VC401_33(0.5-0.9m)
			Client sampling date / time	[29-May-2015]	[29-May-2015]	[29-May-2015]	[29-May-2015]	[29-May-2015]
Compound	CAS Number	LOR	Unit	EB1523405-011	EB1523405-012	EB1523405-013	EB1523405-014	EB1523405-015
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.4**	**9.4**	**9.3**	**9.4**	**9.4**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.025**	**0.056**	**0.048**	**0.029**	**0.072**
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**15**	**35**	**30**	**18**	**45**
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**35.8**	**26.4**	**25.6**	**47.6**	**31.9**
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**7150**	**5270**	**5110**	**9510**	**6370**
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**11.4**	**8.46**	**8.20**	**15.2**	**10.2**
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	VC401_33(1.7-1.8m)	VC401_33(2.7-2.8m)	BHW2-02(0.95-0.99m)	BHW2-03(0.95-1.00m)	BHW2-09(1.06-1.10m)
			Client sampling date / time	[29-May-2015]	[29-May-2015]	[29-May-2015]	[29-May-2015]	[29-May-2015]
Compound	CAS Number	LOR	Unit	EB1523405-016	EB1523405-017	EB1523405-018	EB1523405-019	EB1523405-020
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	9.2	9.5	9.5	9.3	9.1
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	0.140	0.052	0.007	0.005	0.040
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	87	33	<10	<10	25
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	25.8	2.39	47.8	48.8	19.0
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	5140	477	9560	9750	3800
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	8.25	0.76	15.3	15.6	6.09
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1

Appendix E

Dredged Material Containment Ponds Engineering Risk Analysis

Advisian
WorleyParsons Group

Queensland Government

TECHNICAL MEMORANDUM

DATE 16 July 2015 **PROJECT No.** 1525905-050-TM-Rev1

TO Project Manager
Department of State Development

CC Neil Underhill (Golder)

FROM Russell Merz **EMAIL** RMerz@golder.com.au

RISK ANALYSIS OF DREDGED MATERIAL CONTAINMENT - ABBOT POINT GROWTH GATEWAY

This memo documents the risk analysis undertaken for the proposed Dredged Material Containment Ponds (DMCP) at the APGG Project, with reference to groundwater seepage, loss of containment as well as catastrophic failure, with consideration of meteorological and tidal events and predicted sea level rise and with project related risks associated with schedule and cost.

The risks considered in the design of the pond structure have been assessed in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures[1] (The Manual). Findings and risks contained within documents in the public domain regarding recent high profile failures of dredge control bunds were also considered (Department of the Environment, 2014).

The risk event scenarios for the structure were broadly categorised as per the following failure event scenarios as given in The Manual:

- **Failure to contain – seepage** – spills or releases to ground and/or groundwater via seepage from the floor and/or sides of the embankment
- **Failure to contain – overtopping** – spills or releases from the embankment that result from loss of containment due to overtopping of the embankment
- **Dam break** – collapse of the embankment due to any possible cause.

Use a Risk Management Approach

A risk management process is a systematic way of making a workplace as safe as possible and it should also be used as part of the design process. It involves the following steps

- Identify reasonably foreseeable hazards associated with the design of the structure
- If necessary, assess the risks arising from the hazards
- Eliminate or minimise the risk by designing control measures, and
- Review the control measures.

[1] Department of Environmental and Heritage Protection (DEHP), 2014. *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures,* EM635 Version 4. Queensland.

Risk Management Process

The risk management methodology applied for this assessment is consistent with the risk management process outlined in AS/NZS 4360:2004 'Risk Management'. Figure 1 below provides an overview of the risk management approach as depicted in the Standard.

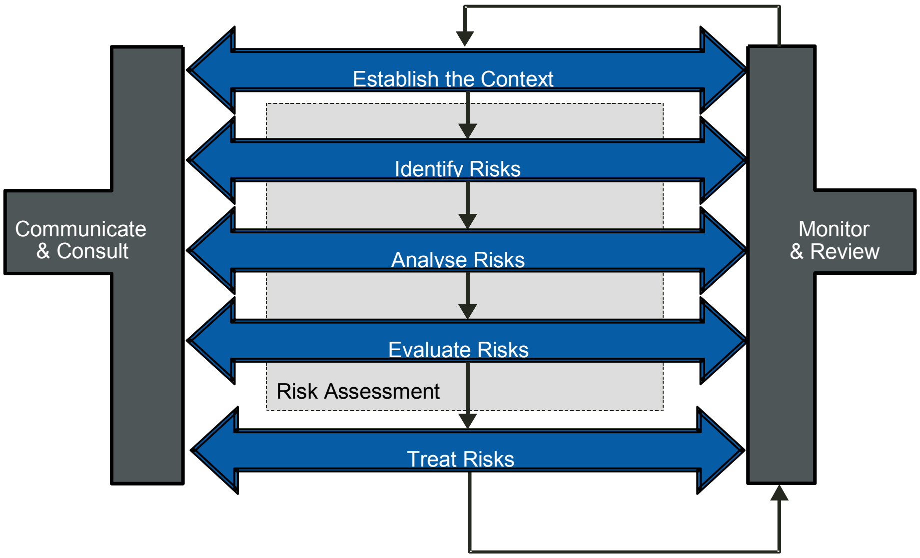


Figure 1: Risk Management Process – Overview

The risk management process consists of a staged approach involving establishing the context, identification, analysis, evaluation, treatment and monitoring of current, new and emerging risks.

Details of the risk analysis process are attached to this document.

Limitations and scope of analysis

This risk analysis has been limited to the environmental and infrastructural consequences of failure of the DMCP during construction, operation with incoming dredged material, and post dredging.

In particular,

- Impact to groundwater from seepage of saline water through the pond floor or through the embankment wall
- Failure of the embankment wall and associated loss of containment due to various identified risks including
  - overtopping
  - failure from external erosion caused by stormwater, storm surge, tide or predicted sea level rise
  - failure from other geotechnical mechanisms, such as instability
  - failure from internal erosion that occurs when fine soil particles from within an embankment are carried by seeping water to cause a piping failure
- The performance of the embankment due to localised flood levels, or storm surge and tide, resulting in elevated water levels on the outside of the embankment wall.

The risk analysis has considered potential failure modes, causal events and mitigation measures following risk management methodology consistent with the risk management process outlined in AS/NZS 4360:2004 'Risk Management'. The assessment presented should not be considered as a full safety in design review and does not document risks to construction and operational personnel.

Site risk context and scenario

A dam break failure would likely result in adverse effects to the downstream wetlands area due to the mobilisation of the contained solids and subsequent deposition in the wetland.

A dam break failure would likely result in damage to current infrastructure such as the adjacent Abbot point Coal Terminal, Aurizon rail lines, and access tracks. Future planned down-gradient infrastructure also includes port infrastructure projects that may be impacted by failure of the DMCP.

Embankment failure mode groupings that have been considered include but are not limited to:

Climate change and storm surge scenario impacts

Design water levels for "existing" and "year 2100" climate change scenario cyclone-induced extreme water levels from storm surge and tides were provided (BMT WBM, 2014) for the following Annual Exceedance Probability (AEP) and Annual Recurrance Interval (ARI) cases:

- 1% AEP – corresponding to 1 in 100 year ARI (or 1% probability of exceedance in any given year)
- 0.2% AEP – corresponding to 1 in 500 year ARI (or 0.2% probability of exceedance in any given year)
- 0.1% AEP – corresponding to 1 in 1000 year ARI (or 0.1% probability of exceedance in any given year).

Seepage and overtopping

Seepage through the perimeter embankment of the DMCP and overtopping the embankment were considered for infrastructure loss purposes. Due to the location of the ponds in relatively elevated positions, two hydraulic gradient scenarios for both seepage and overtopping events were considered:

- Maximum water level in the ponds due to dredging operation and cumulative rainfall corresponding to no water level on the external / downstream side. This was deemed to be a representative case.
- Maximum water level on the external / downstream side due to regional flooding and / or storm surge associated with extreme tide and sea level rise, corresponding to no water level on the internal / upstream side. This was deemed to be a non-representative case as DMCP is at an elevation above the extreme water levels considered.

Failure modes were then assessed for each of these conditions, incorporating knowledge of historical failure events for similar structures.

Erosion and destabilisation

Soft soil foundation conditions, potential inundation, materials used in the construction of the DMCP along with the design and construction methodology can each contribute to failure modes associated with erosion and destabilisation of the embankment.

Internal erosion leading to "piping" and subsequent failure of earth embankments occurs when fine soil particles from within an embankment are carried by seeping water to cause "internal" erosion. This internal erosion is difficult to detect and may lead to collapse of the embankment.

Poor operations and deposition practices can also be a contributing causal factor. Failure modes associated with these types of embankment degradation were assessed.

Other contributing failure mechanisms

Other mechanisms for embankment degradation can be attributed to events such as bush fires which have a potential to damage geosynthetic components of the embankment or degrade erosion control vegetation.

Operational risk assessment

The full risk assessment matrix is given in ***Attachment 1***. It outlines the risk description, the root cause / source of risk, the category of risk consequence, and a baseline risk assessment with consequence and probability/likelihood contributing to a risk ranking (score derived from a 5x5 consequence x probability matrix) and subsequent risk level (Extreme, High, Medium and Low). The consequence assessment is limited to the containment pond structures and receiving infrastructure environment. Definitions of the input criteria are provided in Attachment 2.

A treatment plan composed of controls to be implemented is provided for each risk item, and then the residual risk after such controls is assessed and assigned a final residual risk level. Management of short and long term risks should be prioritised according to the residual risk level.

Documentation, Data and Guidelines

The following documentation/data/guidelines was considered in this assessment.

1) Australian Government Department of the Environment, 2014. *Protected Matters Interactive Mapping System*, available at http://www.environment.gov.au/topics/about-us/legislation/environment-protection-and-biodiversity-conservation-act-1999/protectedl accessed November 2014.

2) Australian Government Department of Sustainability, Environment, Water, Population and Communities, Referral of Proposed Action: Abbot Point Port and Wetland Strategy, October 2014.

3) Australian Government Department of Sustainability, Environment, Water, Population and Communities, Referral of Proposed Action: Abbot Point Dredging and Onshore Placement of Dredged Material, October 2014.

4) BMT WBM, 2014. Coastal inputs – Abbot point approvals project risk analysis of dredge material containment, L.B21155.002, 18 November 2014.

5) CDM Smith, 2013. Final Environmental Impact Statement Volume 1

6) GHD, 2010. Hancock Prospecting Pty Ltd, Alpha Coal Project (Rail) Abbot Point Surface Water Model, September 2010.

7) GVK layouts of adjoining lease.

8) Queensland Government, Department of Energy and Water Supply, 2012. Guidelines for Failure Impact Assessment of Water Dams

9) Queensland Government, Department of Environmental and Heritage Protection (DEHP), 2013. *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures,* EM635 Version 4. Queensland.

10) Queensland Government, Department of State Development, Infrastructure and Planning, 2014. *SPP Interactive Mapping System*, available at http://www.dsdip.qld.gov.au/about-planning/spp-mapping-online-system.html accessed November 2014.

11) Queensland Government, Department of Environment and Resource Management (DERM) (2010), Guidelines on Acceptable Flood Capacity for Dams

12) Queensland Government, Water Supply (Safety and Reliability) Act 2008.

Conclusion

The implementation of the suggested controls is expected to minimise the identified risks associated with dredged material containment for this site.

Donovan Rowe
Principal Design Engineer

Russell Merz
Principal

SAC/DR-RDM/kg

Attachment 1: Risk Assessment Matrix
Attachment 2: Risk Management Process

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Attachment 1: Risk Assessment Matrix

Project: Abbot Point Growth Gateway Project
Component: Dredged material containment pond
Date: 16-Jul-15
Baseline Risk Assessment: Revision 1

Risk No	Risk Description	Root cause / Source of risk	Risk Consequence	Baseline Risk: Consequence	Baseline Risk: Probability	Baseline Risk: Ranking	Baseline Risk: Risk Level	Treatment Plan (Preventative and Corrective)	Residual Risk Assessment: Consequence	Residual Risk Assessment: Probability	Residual Risk Assessment: Ranking	Residual Risk Assessment: Risk Level
1	Piping, leading to embankment breach	Internal erosion due to seepage (from any direction and any source)	Infrastructure / Environmental	3	3	9	M	Comprehesive site investigations Appropriately qualified professional design considering fill material, embankment geometry, appropriate filters and operational aspects Appropriate material specifications and Quality Assurance/Quality Control (QA/QC) program in Construction Specifications Third party design review Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider embankment condition monitoring requirements	3	1	3	L
2	Erosion - crest, leading to embankment breach	Wave due to wind	Infrastructure / Environmental	3	3	9	M	Appropriately qualified professional design considering design storm ARI's, crest geometry, fetch control and capping construction materials Appropriate material specifications and QA/QC program in Construction Specifications Third party design review Construction by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program to consider embankment monitoring requirements	3	1	3	L
3	Destabilisation – external walls (downstream), leading to embankment failure	Slope failure	Infrastructure / Environmental	3	3	9	M	Appropriately qualified professional design considering embankment and geotechnical interactions Appropriate construction materials and construction methodology to be specified in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider outer slopes monitoring regime.	3	1	3	L
4	Embankment overtopping, leading to embankment failure	Settlement of embankment (Consolidation or liquefaction following earthquake)	Infrastructure / Environmental	3	3	9	M	Appropriately qualified professional design considering embankment and foundation soil interactions, soil liquefaction and seismic stability Appropriate subgrade preparation and construction materials to be specified in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider settlement monitoring regime	3	1	3	L
5	Embankment overtopping, leading to embankment failure	Rainfall	Infrastructure / Environmental	3	3	9	M	Appropriately qualified professional design considering design storm and freeboards Operation by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program to consider stormwater management planning and inspection requirements after significant events	3	1	3	L

Note: This risk analysis pertains exclusively to the containment pond embankment.

Project: Abbot Point Growth Gateway Project
Component: Dredged material containment pond
Date: 16-Jul-15
Baseline Risk Assessment: Revision 1

Risk No	Risk Description	Root cause / Source of risk	Risk Consequence	Baseline Risk				Treatment Plan (Preventative and Corrective)	Residual Risk Assessment			
				Consequence	Probability	Ranking	Risk Level		Consequence	Probability	Ranking	Risk Level
6	Embankment overtopping, leading to embankment failure	Wave due to wind	Infrastructure / Environmental	3	3	9	M	Appropriately qualified professional design considering design storm and freeboards Operation by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program to consider stormwater management planning and inspection requirements after significant events	3	1	3	L
7	Embankment overtopping, leading to embankment failure	Poor operation	Infrastructure / Environmental	3	3	9	M	Appropriately qualified professional design considering design storm and freeboards, spillway armouring Operation by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program to include depositional and stormwater management planning and inspection requirements after significant events	3	1	3	L
8	Spillway overtopping, leading to embankment failure	Rainfall	Infrastructure / Environmental	3	3	9	M	Appropriately qualified professional design considering design storm and freeboards, spillway armouring Operation by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program to include stormwater management planning and inspection requirements after significant events	3	1	3	L
9	Spillway overtopping, leading to embankment failure	Poor operations	Infrastructure / Environmental	3	3	9	M	Appropriately qualified professional design considering design storm and freeboards, spillway armouring Operation by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program to include stormwater management planning and inspection requirements after significant events	3	1	3	L
10	Erosion – internal walls (upstream), leading to embankment breach	Wave due to wind	Infrastructure / Environmental	3	3	9	M	Appropriately qualified professional design considering fetch, freeboard and runup controls, erosion resistant upstream material Appropriate material specifications and QA/QC program in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider embankment condition monitoring requirements	3	1	3	L
11	Erosion - crest, leading to embankment breach	Rainfall	Infrastructure / Environmental	3	3	9	M	Appropriately qualified professional design considering design storm, crest geometry, and capping construction materials Appropriate material specifications and QA/QC program in Construction Specifications Construction by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program to consider embankment monitoring requirements	3	1	3	L

Note: This risk analysis pertains exclusively to the containment pond embankment.

Risk No	Risk Description	Root cause / Source of risk	Risk Consequence	Baseline Risk				Treatment Plan (Preventative and Corrective)	Residual Risk Assessment			
				Consequence	Probability	Ranking	Risk Level		Consequence	Probability	Ranking	Risk Level
12	Destabilisation – internal walls (upstream) leading to embankment failure	Slope failure	Infrastructure / Environmental	3	3	9	M	Comprehesive site investigations Appropriately qualified professional design considering geotechnical interactions between foundation and embankment Appropriate geometry, construction materials, soil improvements and construction methodology to be specified in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider outer slopes monitoring regime	3	1	3	L
13	Tailwater quality not achieved	Dredged material characteristics and settling behaviours not as estimated	Environmental / Project	3	3	9	M	Appropriately qualified professional design considering dredged material characteristics Additional studies undertaken to characterise dredged material Operation by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program	3	1	3	L
14	Tailwater quality not achieved	Insufficient storage capacity due to actual bulking factor varying from design basis	Environmental / Project	3	3	9	M	Appropriately qualified professional design considering dredged material characteristics Additional studies undertaken to characterise bulking factor and sedimentation properties of dredged material Operation by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program during dredging	3	1	3	L
15	Destabilisation – external walls (downstream), leading to embankment failure	Low strength foundation	Infrastructure / Environmental	3	2	6	M	Appropriately qualified professional design considering embankment and geotechnical interactions Appropriate construction materials, soil improvements and construction methodology to be specified in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider outer slopes monitoring regime	3	1	3	L
16	Transverse destabilisation, leading to embankment failure	Differential settlement due to differential loading of foundation soils	Infrastructure / Environmental	3	2	6	M	Appropriately qualified professional design considering embankment and foundation soil interactions Appropriate subgrade preparation, construction materials and construction methodology to be specified in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider settlement monitoring regime	3	1	3	L
17	Transverse destabilisation, leading to embankment failure	Transverse cracking due to differential loading of foundation soils	Infrastructure / Environmental	3	2	6	M	Appropriately qualified professional design considering embankment and foundation soil interactions Appropriate subgrade preparation, construction materials and construction methodology to be specified in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider settlement monitoring regime	3	1	3	L

Note: This risk analysis pertains exclusively to the containment pond embankment.

Risk No	Risk Description	Root cause / Source of risk	Risk Consequence	Baseline Risk				Treatment Plan (Preventative and Corrective)	Residual Risk Assessment			
				Consequence	Probability	Ranking	Risk Level		Consequence	Probability	Ranking	Risk Level
18	Erosion – internal walls (upstream), leading to embankment breach	Scour due to poor operations (discharge close to embankment)	Infrastructure / Environmental	3	2	6	M	Appropriately qualified professional design considering wall and layout geometry and potential armouring Appropriate material specifications and QA/QC program in Construction Specifications Construction by qualified and experienced contractors Operation by qualified and experienced operator with appropriate operational planning prior to commencement	3	1	3	L
19	Erosion - crest, leading to embankment breach	Tailwater pipe failure	Infrastructure / Environmental	3	2	6	M	Appropriately qualified professional design considering wall and tailwater pipe layout geometry and interactions Construction by qualified and experienced contractors Operation by qualified and experienced operator	3	1	3	L
20	Destabilisation – internal walls (upstream) leading to embankment failure	Low strength foundation	Infrastructure / Environmental	3	2	6	M	Appropriately qualified professional design considering embankment and geotechnical interactions Appropriate geometry, construction materials, soil improvements and construction methodology to be specified in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider outer slopes monitoring regime	3	1	3	L
21	Destabilisation – internal walls (upstream) leading to embankment failure	Earthquake	Infrastructure / Environmental	3	2	6	M	Appropriately qualified professional design considering embankment and geotechnical interactions Appropriate geometry, construction materials, soil improvements and construction methodology to be specified in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider outer slopes monitoring regime	3	1	3	L
22	Destabilisation – internal walls (upstream) leading to embankment failure	Rapid drawdown of internal water levels	Infrastructure / Environmental	3	2	6	M	Appropriately qualified professional design considering embankment, geotechnical and operational interactions Consider retention of protective dredged materials around perimeter in design and operations manual Appropriate geometry, construction materials, soil improvements and construction methodology to be specified in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider internal slopes monitoring regime	3	1	3	L
23	Destabilisation – external walls (downstream), leading to embankment failure	Earthquake	Infrastructure / Environmental	3	2	6	M	Appropriately qualified professional design considering embankment geometry and geotechnical conditions Consideration of siesmic conditions Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider monitoring regime after seismic events Operation by qualified and experienced operator	3	1	3	L

Risk No	Risk Description	Root cause / Source of risk	Risk Consequence	Baseline Risk				Treatment Plan (Preventative and Corrective)	Residual Risk Assessment			
				Consequence	Probability	Ranking	Risk Level		Consequence	Probability	Ranking	Risk Level
24	Excessive seepage out of pond: lateral through embankment	Normal operations (dredging associated water and rainfall on pond area)	Infrastructure / Environmental	2	3	6	M	Comprehensive site investigations Appropriately qualified professional design considering use of low permeability construction materials Appropriate material specifications and QA/QC program in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider seepage monitoring requirements	2	2	4	L
25	Fire damage	Bush fires	Infrastructure / Environmental	2	3	6	M	Appropriately qualified professional design considering wall materials, embankment geometry and protective covers to heat sensitive design elements Construction by qualified and experienced contractors Operation by qualified and experienced operator. Appropriate surveillance, monitoring and maintenance program	2	1	2	L
26	Tailwater quality not achieved	Insufficient storage capacity due to dredging volume exceeding design	Environmental / Project	3	2	6	M	Operation by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program during dredging	3	1	3	L
27	Tailwater quality not achieved	Introduction of tailwater quality criteria not in design basis More stringent discharge criteria applied	Environmental / Project	3	2	6	M	Early engagement with Environmental Authorities Appropriately qualified professional Environmental Impact Assessment undertaken Operation by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program	3	1	3	L
28	Impact to adjacent infrastructure	Aerial extent of ponds and associated infrastructure	Project	2	3	6	M	Appropriate stakeholder engagement Appropriately qualified professional design considering impacts to adjacent existing and proposed infrastructure Construction by qualified and experienced contractors	2	1	2	L
29	Groundwater impacts on construction	DMCP excavation intersects or is in close proximity to groundwater	Project	3	2	6	M	Comprehensive site investigations Appropriately qualified professional design and geotechnical investigation Appropriate borrow area management Construction by qualified and experienced contractors	2	1	2	L
30	Design criteria /details rejected by Independent reviews or Authorities	Differing professional opinions	Project	3	2	6	M	Early appointment and consultation with appropriately qualified independent reviewers and Authorities	2	1	2	L
31	Erosion – external walls (downstream), leading to embankment failure	Storm event	Infrastructure / Environmental	2	2	4	L	Appropriately qualified professional design considering embankment and hydrological interactions Appropriate erosion resistant construction materials and construction methodology to be specified in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider outer slopes monitoring regime	3	1	3	L
32	Excessive vertical seepage out of pond impacting embankment stability	Normal operations (dredging associated water and rainfall on pond area)	Infrastructure / Environmental	2	2	4	L	Comprehensive site investigations Conduct field and laboratory testing on site strata Conduct groundwater movement modelling Maximise the use of natural low permeability strata Surveillance, monitoring and maintenance program to consider seepage monitoring requirements	2	1	2	L

Note: This risk analysis pertains exclusively to the containment pond embankment.

Project: Abbot Point Growth Gateway Project
Component: Dredged material containment pond
Date: 16-Jul-15
Baseline Risk Assessment: Revision 1

Risk No	Risk Description	Root cause / Source of risk	Risk Consequence	Baseline Risk				Treatment Plan (Preventative and Corrective)	Residual Risk Assessment			
				Consequence	Probability	Ranking	Risk Level		Consequence	Probability	Ranking	Risk Level
33	Excessive vertical seepage out of pond impacting adjacent infrastructure	Normal operations (dredging associated water and rainfall on pond area)	Infrastructure / Environmental	2	2	4	L	Comprehensive site investigations Conduct field and laboratory testing on site strata Conduct groundwater movement modelling Maximise the use of natural low permeability strata Surveillance, monitoring and maintenance program to consider seepage monitoring requirements	2	1	2	L
34	Excessive vertical seepage of saline water out of pond impacting adjacent infrastructure	Normal operations (dredging associated water and rainfall on pond area)	Environment	2	2	4	L	Comprehensive site investigations Conduct field and laboratory testing on site strata Conduct groundwater movement modelling Maximise the use of natural low permeability strata Surveillance, monitoring and maintenance program to consider seepage monitoring requirements	2	1	2	L
35	Construction materials imbalance	Insufficient suitable materials available from borrow	Project	2	2	4	L	Comprehensive site investigations Appropriately qualified professional design considering geotechnical constraints of local and off site borrow sources Appropriate construction materials and construction methodology to be specified in Construction Specifications Construction by qualified and experienced contractors	2	1	2	L
36	Destabilisation – external walls (downstream), leading to embankment failure	Rapid drawdown of external water levels	Infrastructure / Environmental	2	1	2	L	Comprehensive site investigations Appropriately qualified professional design considering embankment and hydrological interactions Appropriate construction materials and construction methodology to be specified in Construction Specifications Construction by qualified and experienced contractors. Surveillance, monitoring and maintenance program to consider outer slopes monitoring regime.	3	1	3	L
37	Acid Sulfate Soils (ASS)/Potential ASS (PASS) exposed from DMCP construction earthworks	Pond excavation intersects or is in close proximinty to ASS/PASS	Environmental	2	1	2	L	Comprehensive site investigations Appropriately qualified professional design considering ASS/PASS likelihood Appropriate borrow area management Development of an approriate ASS management plan Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider ASS/PASS monitoring requirements	2	1	2	L
38	ASS/PASS exposed from dredged material, during dredging operation	Dredged material characteristics not as estimated	Environmental	2	1	2	L	Comprehensive site investigations Appropriately qualified professional design considering ASS/PASS likelihood Development of an approriate ASS management plan Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider ASS/PASS monitoring requirements	1	1	1	L
39	ASS/PASS exposed from dredged material, post-dredging	Dredged material characteristics not as estimated	Environmental	2	1	2	L	Comprehensive site investigations Appropriately qualified professional design considering ASS/PASS likelihood Development of an approriate ASS management plan Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider ASS/PASS monitoring requirements	1	1	1	L

Note: This risk analysis pertains exclusively to the containment pond embankment.

Risk No	Risk Description	Root cause / Source of risk	Risk Consequence	Baseline Risk: Consequence	Baseline Risk: Probability	Baseline Risk: Ranking	Baseline Risk: Risk Level	Treatment Plan (Preventative and Corrective)	Residual Risk Assessment: Consequence	Residual Risk Assessment: Probability	Residual Risk Assessment: Ranking	Residual Risk Assessment: Risk Level
40	Seepage into pond from external water sources	Storm surge / High tides	Environmental	1	1	1	L	Comprehensive site investigations Appropriately qualified professional design considering use of low permeability construction materials embankment geometry, appropriate filters Appropriate material specifications and QA/QC program in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider seepage monitoring requirements after sigificant events	1	1	1	L
41	Seepage into pond from external water sources	Rainfall induced flooding	Environmental	1	1	1	L	Appropriately qualified professional design considering use of low permeability construction materials embankment geometry, appropriate filters, stormwater drainage Appropriate material specifications and QA/QC program in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider drain maintenance and/or seepage monitoring requirements after sigificant events	1	1	1	L
42	Seepage into pond from external water sources	Climate change sea level rise	Environmental	1	1	1	L	Appropriately qualified professional input to expected sea level rise from climate change scenarios Appropriately qualified professional design considering use of low permeability construction materials embankment geometry, appropriate filters Appropriate material specifications and QA/QC program in Construction Specifications Construction by qualified and experienced contractors Surveillance, monitoring and maintenance program to consider seepage monitoring requirements after sigificant events	1	1	1	L
43	Destabilisation – internal walls (upstream) leading to embankment failure	Contractor physically damaging the liner with plant and equipment during dredging	Infrastructure / Environmental	1	1	1	L	Appropriately qualified professional design considering wall and layout geometry and potential armouring Appropriate material specifications and QA/QC program in Construction Specifications Construction by qualified and experienced contractors Operation by qualified and experienced operator with appropriate operational planning prior to commencement Appropriate Operating protocols in place Appropriate performance hurdles / specifications within the tender documentation Operation by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program	1	1	1	L
44	Destabilisation – internal walls (upstream) leading to embankment failure	Items to be designed by the contractor (e.g. weir boxes, delivery pipeline, return pipeline, etc.) potentially compromising the Principal supplied design	Infrastructure / Environmental	1	1	1	L	Appropriately qualified professional design considering wall and layout geometry and potential armouring Appropriate material specifications and QA/QC program in Construction Specifications Construction by qualified and experienced contractors Operation by qualified and experienced operator with appropriate operational planning prior to commencement Appropriate Operating protocols in place Appropriate performance hurdles / specifications within the tender documentation Operation by qualified and experienced operator Appropriate surveillance, monitoring and maintenance program	1	1	1	L

Note: This risk analysis pertains exclusively to the containment pond embankment.

Attachment 2: Risk Management Process

1.0 RISK MANAGEMENT PROCESS

The risk management methodology applied for this assessment is consistent with the risk management process outlined in AS/NZS 4360:2004 'Risk Management'. **Figure 1** below provides an overview of the risk management approach as depicted in the Standard.

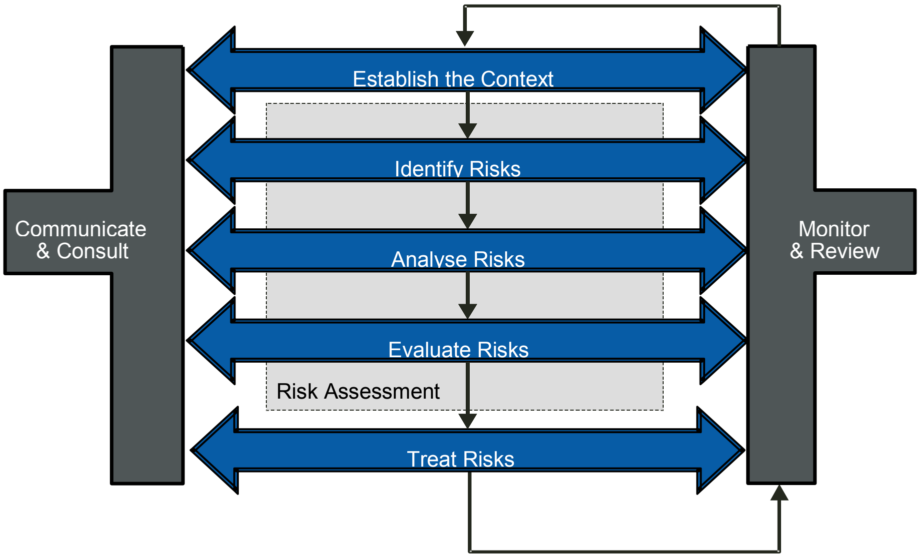

Figure 1: Risk Management Process – Overview

The risk management process consists of a staged approach involving establishing the context, identification, analysis, evaluation, treatment and monitoring of current, new and emerging risks.

1.1 Establishing the Context

The first step in the risk management process is to define the basic parameters in which the risk must be managed and set the scope for the risk management process. Establishing the context includes consideration of the external environment and the purpose of the risk management activity. Drivers for risk management in respect of the external environment include:

- Client expectations;
- Contractual obligations;
- Legislation/regulation;
- Key external stakeholders, and
- Industry requirements and expectations.

1.2 Identify the Risks

The next step in the risk management process is to identify the risks to be managed. There are several recognised techniques for identifying risk and the most appropriate technique or a combination of techniques should be chosen, these include:

- **Brainstorming** is a structured session, involving management representatives and staff, usually conducted in a workshop;
- **Scenario Analysis** is where each risk event should be developed into a loss scenario so that aspects of risk treatment can be considered;

1.3 Analyse the Risks

The risk analysis step is about quantifying the risk to enable further evaluation and assessment. Risk analysis involves consideration of the sources of risk, their consequences and the likelihood of the identified risk occurring and current control measures.

The risk analysis will result in a rating of identified risks that provides the basis for decisions on whether risks need to be treated and, if deemed necessary, on the most appropriate and cost effective risk reduction measures.

The risk analysis is originally undertaken to assess **absolute risk**, i.e. it looks at the risk level **before engineering and management controls have been determined**. It determines the risk level for the 'uncontrolled risk'. The purpose of determining a risk rating for absolute risk is to demonstrate what could potentially be the outcome of a risk if management controls were not in place or are in place but not being adhered to.

1.3.1 Assessing the Likelihood & Consequence

Analysis of the likelihood (frequency) and consequences (impact) of the identified risk occurring is required. The analysis requires an objective assessment, based on rating criteria for:

- Likelihood (Rare, Unlikely, Possible, Likely and Almost Certain); and
- Consequence (Insignificant, Minor, Moderate, Major and Extreme).

The likelihood of a risk occurring should be assessed using **Table 1** as a guide.

Table 1: Likelihood Rating Criteria

RATING	Likelihood Frequency	Similarity
ALMOST CERTAIN (5)	Event is expected to occur in most circumstances. Could occur more than once a year.	Almost certain to happen
LIKELY (4)	Event will probably occur in most circumstances. Event could occur in a 1-2 year period.	Likely to happen at some point
POSSIBLE (3)	Event might occur at some time. Event occurs less than one event per year but more than one event every five years.	Possible
UNLIKELY (2)	Event could occur at some time. Event occurs less than one event every five years.	Not likely to happen
RARE (1)	Event may only occur in exceptional circumstances or is unlikely to occur.	Rare, practically impossible

Select the likelihood category that is most suitable:

1. <u>Frequency</u> is for risks that are <u>time based</u>.
2. <u>Similarity</u> is for risks that are <u>project based</u>.

Consequence categories provide a qualitative measure of the credible "worst foreseeable outcome" impact of a risk. This is defined as a maximum loss, which could occur from the risk under consideration as a result of a single outcome, considered being in the realms of probability. **Table 2** is used to select the most appropriate category for the risk under consideration.

Table 2: Consequence Criteria

Criteria	Health and Safety	Property or production	Environmental and community	Financial impact
5 Extreme	Could kill or permanently disable.	Could cause extreme damage	A major event creating irreversible environmental damage, loss of company credibility with key stakeholders, national publicity and complaints or could close the operation permanently.	$ 10M+
4 Major	Could cause serious injury or disease (major Lost Time Injury - LTI)	Could cause major damage	An event having a substantial and permanent consequence to the environment such as an environmental incident which would result in prosecution, adverse local publicity and complaints.	> $ 2.5 M and < $ 10M
3 Moderate	Could cause typical Medical Treatment Injury, Restricted Work Injury, or LTI	Could cause moderate damage	An event creating substantial temporary or minor permanent damage to the environment, such as a reportable incident. Not likely to result in prosecution or adverse publicity.	> $0.5M and < $2.5M
2 Minor	Could cause First-Aid injury	Could cause minor damage	An event having temporary and minor effects on the environment, such as a non-reportable environmental incident, e.g.: a minor oil spill.	> $ 50 000 but < $0.5M
1 Insignificant	Couldn't cause injury or disease	Couldn't cause damage	No detrimental impact on the environment is measurable or envisaged.	<$ 50 000

1.3.2 Determining the Risk Rating

The likelihood and consequence of a risk occurring are then used to determine the risk rating of either low, moderate, high or extreme. **Table 3** below should be used to determine the risk rating for the risk.

Table 3: Risk Matrix

Likelihood	Consequence				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Extreme 5
5 (Almost Certain)	Moderate	High	High	Extreme	Extreme
4 (Likely)	Moderate	Moderate	High	High	Extreme
3 (Possible)	Low	Moderate	Moderate	High	High
2 (Unlikely)	Low	Low	Moderate	Moderate	High
1 (Rare)	Low	Low	Low	Moderate	High

1.3.3 Assessment of Controls

After identifying the potential risks, the next step is to identify and evaluate the existing and potential new controls. Existing controls or mitigating strategies are an existing design, process, policy, practice or other action, that act to reduce the likelihood (i.e. frequency) or consequence (i.e. impact) of the identified risk occurring.

Once the effectiveness of existing and new controls is identified a subsequent risk analysis is carried out to determine the **managed risk**. The same technique defined in sections 1.3.1 and 1.3.2 is applied to assess and rate the risk. The managed risk analysis looks at the risk level **after engineering and management controls and their effectiveness have been determined**.

1.3.4 Evaluate Risks

The purpose of risk evaluation is to make decisions based on the outcomes of the risk analysis about which risks need treatment and the treatment priorities. Risks need to be evaluated and prioritised based on the outcome of the Risk Rating (as per Table 3).

Appendix F

Offset/Net Benefit Strategy

Advisian

WorleyParsons Group

Queensland Government

Abbot Point Growth Gateway Project

Offset / Net Benefit Strategy

301001-01956-00-EN-REP-0010

15 October 2015

Disclaimer

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Acronyms and Abbreviations

Abbreviation/Acronym	Description
Abbot Point	Refers to the existing Abbot Point port area and adjacent industrial land (includes the onshore parts of the project area)
CQU	Central Queensland University
CSD	Cutter Suction Dredge
DMCP	Dredged Material Containment Ponds
DoE	Australian Department of Environment
DSD	Queensland Department of State Development
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
GBR	Great Barrier Reef
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GBRWHA	Great Barrier Reef World Heritage Area
ha	Hectares
JCU	James Cook University
m	Meters
MNES	Matters of national environmental significance
MSES	Matters of State environmental significance
Mtpa	Million tonnes per annum
NPV	Net Present Value
NQBP	North Queensland Bulk Ports Corporation

Abbreviation/Acronym	Description
OUV	Outstanding Universal Value
PPDA	Port Priority Development Area
t	tonnes
TSS	Total Suspended Solids
μm	microns

1 Introduction

1.1 Project overview

The Queensland Government intends the Port of Abbot Point to be declared a Priority Port Development Area (PPDA) under the proposed *Sustainable Ports Development Act*. The Queensland Government's decision to concentrate port developments in five PPDAs (including Abbot Point) is consistent with the UNESCO World Heritage Committee's recommendation that port development be restricted to long-established port areas within or adjoining the Great Barrier Reef World Heritage Area (GBRWHA).

Master Planning for the Abbot Point PPDA is currently underway and will cover land and marine areas that extend beyond the operational port area. The Master Plan will outline the Queensland Government's strategic vision and outcomes sought for the PPDA over the next 30 years, providing the boundaries of the PPDA and the precincts and desired activities within the PPDA, incorporating environmental, economic, safety and community outcomes. The Queensland Government is committed to ensuring that the biodiversity and function of ecosystems present within and adjacent to port lands are protected into the future.

Consistent with these planning intentions, the Abbot Point Growth Gateway Project is proposed to support the development of Port of Abbot Point in a manner that:

- Protects the Great Barrier Reef (GBR)
- Protects the Caley Valley Wetland.

Components of the Project include:

- Construction of onshore Dredged Material Containment Ponds (DMCP)
- Capital dredging of approximately 1.1 million m^3 (Mm^3) *in situ* volume of previously undisturbed seabed for new berth pockets and ship apron areas required to support the development of Terminal 0 (T0)
- Relocation of the dredged material to the DCMPs and offshore discharge of return water
- Ongoing management of the dredged material including its removal, treatment and beneficial reuse within the port area and the State Development Area, where appropriate.

In developing the proposed action there was considerable analysis and consideration of the principles of Ecologically Sustainable Development as well as the guiding principles contained in the *Protocol to the Convention on the Prevention of marine Pollution by Dumping of Wastes and Other Matter 1972*. Specifically, the following measures are incorporated into the proposed action:

1. Eliminating the need to dispose of dredged material offshore in the Great Barrier Reef Marine Park (GBRMP) and GBRWHA
2. Using onshore areas that are already disturbed
3. Maximising the beneficial reuse of dredged material through the application of best practice placement and material management techniques to achieve recovery of construction grade sands.

1.2 Proponent

The Proponent for this project, with ongoing management responsibilities, is the Queensland Department of State Development (DSD). It is proposed that responsibility for delivery of the Project would be transferred to North Queensland Bulk Ports (NQBP) prior to the commencement of construction.

1.3 Scope

Under the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) the Project is a controlled action with the following controlling provisions:

- World Heritage properties
- National Heritage places
- Listed threatened species and communities
- Listed migratory species
- Commonwealth Marine Areas
- Great Barrier Reef Marine Park.

An Environmental Impact Statement (EIS) under the EPBC Act has been prepared for the Abbot Point Growth Gateway Project to address the information requirements of the EIS Guidelines issued by the Australian Government Department of the Environment (DoE) and was made available for public comment between 21 August and 18 September 2015.

The EIS sets out the measures for mitigation and avoidance of impacts on Matters of National Environmental Significance (MNES) and documents assessment of the residual impacts on those matters in accordance with accepted guidelines and current knowledge.

The impact assessment process has determined that there are no significant residual impacts of the Project on MNES, and therefore no requirement to offset impacts in accordance with the EPBC Act *Environmental Offsets Policy (2012)*. However, independent of this policy, there is a requirement to achieve a net benefit through offsetting impacts that cannot be avoided or mitigated within the GBRWHA.. Specifically, the EIS guidelines state that *"the EIS must demonstrate how the proposed action will provide a net benefit for water quality in the Great Barrier Reef World Heritage Area, consistent with the Reef 2050 Long-Term Sustainability Plan (2015)".*

Residual impacts of the Project on GBRWHA values that cannot be avoided or fully mitigated are:

1. The exposure of 9,938t of fine sediment available for resuspension through the dredging activities
2. Permanent loss of 10.5ha of potential seagrass habitat within the proposed berth pockets.

The scope of this Offset/Net Benefit Strategy is to describe the residual impact and propose an appropriate response that would be delivered to achieve a net benefit to the GBRWHA for these matters as a result of the Project.

The Offset/Net Benefit Strategy draws on the technical assessments and findings of the EIS and this information is not duplicated here.

1.4 EPBC Act Offsets Policy

The EPBC Act *Environmental Offsets Policy (2012)* outlines the Australian Government's approach to the use of environmental offsets under the EPBC Act. Under the Policy, offsets are specifically defined as measures that compensate for the residual significant adverse impacts of an action on the environment after avoidance, mitigation and management measures have been applied. While no significant residual impacts are expected, the delivery of a net benefit for the GBRWHA will satisfy the EPBC Act Offsets Policy principles.

Offset principles under the Policy specify that suitable offsets must:

1. Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action
2. Be built around direct offsets but may include other compensatory measures
3. Be in proportion to the level of statutory protection that applies to the protected matter
4. Be of a size and scale proportionate to the residual impacts on the protected matter
5. Effectively account for and manage the risks of not succeeding
6. Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action)
7. Be efficient, effective, timely, transparent, scientifically robust and reasonable
8. Have transparent governance arrangements, including being able to be readily measured, monitored, audited and enforced.

The proposed offset/net benefit for the Project is assessed against these principles in Section 3.3.1.

2 Residual Impacts

2.1 Water quality

Avoidance of potentially significant impacts to the GBRWHA associated with dredging and offshore placement of dredged material is an important feature of the Project. Using a Cutter Suction Dredge (CSD), the dredged material will be pumped on land to a DMCP. As the material settles, excess water is returned to the ocean and carries with it a quantity of suspended sediment. This is a short-term operation that will continue until dewatering of the dredged material has been achieved.

The dredging process itself will disturb currently stable seafloor sediments, making fugitive fines silt and clay components of the sediment in particular, available for re-suspension by wave energy within the marine environment. Heavier fractions are expected to remain localised and be consolidated within the seabed matrix.

While use of CSD technology and onshore reuse of dredged material reduces as far as possible the impact of the Project on marine water quality, a conservative total estimate of approximately 9,938t of fine silt and clay may become available for re-suspension, principally through the dredging activity, but also partially through the dewatering process.

Based on the calculations outlined in Royal Haskoning DHV (2015) the total mass of fine sediment (<63µm, 40% of all sediments to be dredged) released into the marine environment from dredging and return water is approximately 15,900t. The majority of this mass was suspended by the dredging activity (cutter head), with 780t resulting from the return water discharge. The majority of the fine sand and coarse silts will settle out in close proximity to the operations. The fine silts and clays may disperse further afield.

Bainbridge *et al.* (2012) measured the variation along a salinity gradient and distance from the coast of Total Suspended Sediments (TSS) concentrations and sediment particle size composition for the Burdekin River during peak discharge conditions in December 2010. This study found the fraction of sediments that travelled >3.5km were the fine silts and clay fraction only. The majority of the coarser silts and sands dropped out of suspension within 3.5km of the river mouth. This is consistent with the relevant offset requirement for the previous approval for the dredging of T0, T2 and T3 and offshore placement (EPBC2011/6213), which required offsetting in relation to fine sediments which were defined as clay and fine silts <15.6µm, being the fractions that would be potentially available for resuspension. Logan *et al*. (2013) reported that in shallow water (<20m bathymetry), the fine sediments undergo repeated cycles of resuspension and deposition, until they are eventually deposited either on the deeper seafloor below the reach of storm waves or in north-facing coastal embayments.

The fraction of fine sediment <15.6µm (fine silt and clay) in the sediment to be dredged for T0 represents 25% of all available sediment. This fraction of sediment will disperse the furthest from the cutter head. Based on this definition, the total mass of fine silt and clay which enters the marine environment from the cutter head and return water discharge that is available for resuspension is approximately 9,938t.

To place the predicted one-off event of the generation of 9,938t of fine sediment in a regional context, the Burdekin River and Don River catchments are estimated to contribute a combined 4,203,000t per year of TSS to the GBRWHA in this region (Kroon *et al*. 2010).

While there are no long-term or significant residual impacts on the marine environment predicted from the quantity or quality of sediment generated by the proposed dredging and dewatering processes, the contribution of fine sediment available for resuspension by wave energy within the GBRWHA is a negative impact of the Project that cannot be reasonably mitigated further.

The Proponent is committed to achieving a net benefit to the water quality of the GBRWHA in accordance with the targets and objectives of the *Reef 2050 Long-Term Sustainability Plan* (Reef 2050 Plan) (Commonwealth of Australia, 2015). It is intended to achieve this by undertaking or contributing to an action or actions that result in a reduction of the amount of fine sediment entering the marine environment from local catchments (i.e. the Burdekin River and Don River catchments) by 150% of the quantity of fine sediment conservatively predicted to be generated by the Project.

2.2 Seagrass

Seagrass communities form an important component of the marine ecosystem in nearshore environments throughout the GBRWHA. While seagrasses are currently mostly absent from the 61ha dredging footprint area, and where they are present it is at low densities (1% to 5% cover), seagrasses have historically been present at locations across the dredging footprint area.

Dredging for the development of the T0 berth pockets will deepen the seabed to a depth which results in reduced light levels at the seabed and which is likely to permanently preclude recolonisation by seagrasses from an area of approximately 10.5ha. Results of the latest seagrass survey (undertaken in December 2014 at the end of the most recent growing season), found that no seagrass was present within the berth pocket area.

The sparse and ephemeral seagrass present at the dredging location is not considered to represent important habitat for migratory and threatened species that rely on seagrasses for foraging (e.g. Dugong and marine turtles), and no seagrass is currently present within the berth pockets. No significant residual impacts are predicted as a result of the permanent removal of 10.5ha of potential seagrass habitat from the berth pockets.

The deep water seagrass community in this area is predominantly comprised of the seagrass species, *Halophila* spp. *Halophila* species are small bodied seagrasses that exhibit fast growth habits, are considered well adapted for recovery after disturbance events and are able to exploit resources under high light conditions (Longstaff et al. 1999; McMillan 1991; Hammerstrom et al. 2006; Ralph et al. 2007). Disturbance experiments at Abbot Point demonstrated that *Halophila* spp. can recover quickly (ca. 3 months) through a combination of sexual and asexual reproduction and were capable of complete meadow turnover of biomass within 10 days based on productivity measurements (Unsworth et al. 2010; Rasheed et al. 2014b).

Given the capacity for recovery of the seagrass species present, the remaining, shallower disturbed areas (50.5ha) of the apron dredging footprint and surrounds would retain their potential as seagrass habitat, with only temporary impacts predicted and potential for recolonisation by seagrass and other benthic marine biota over time (<5 years).

Seabed characteristics and light regimes are not predicted to change sufficiently as a result of the Project to preclude the affected areas from recovery, and no significant residual impacts for MNES are predicted. A detailed discussion of the predicted seagrass recolonisation of the apron dredging footprint is provided in Section 4.1.2.3 of the EIS Supplement Report.

It is recognised that the permanent loss of 10.5ha of potential seagrass habitat as a result of the Project is a negative impact in relation to 'habitat important for the conservation of biological diversity in a World Heritage property' that cannot be further mitigated. Actions to ensure a net benefit for seagrass as a result of the Project are warranted.

3 Proposed Offset/Net Benefit Strategy

3.1 Proposed offset type

The EPBC Act Offsets Policy recognises the difficulty in achieving meaningful direct offsets for some ecological communities, and specifically indicates that direct offsets may not sufficiently benefit some poorly understood ecosystems in the Commonwealth marine environment.

Seagrasses occur in locations where physical, chemical and biological conditions are suitable. The factors affecting seagrass growth and distribution are a complex relationship of water depth, light, temperature, pH, salinity, nutrients, substratum type, tidal action and wave action, and seagrass cannot be reliably re-established or directly enhanced without improving the conditions for seagrass distribution and/or growth. An exception is where extreme weather events, such as flooding following cyclones, causes seagrass beds to die in locations where the substrate cannot be naturally reseeded and therefore cannot re-establish.

While most factors affecting seagrass growth and distribution are not able to be manipulated, direct benefits can be achieved through water quality improvements that reduce water turbidity to improve light penetration in existing and potential seagrass habitat where light is a limiting factor.

The Biodiversity Consultancy (2015) report on the determination of suitable financial contributions as offsets within the Reef Trust (Dutson *et al,.* 2015) recommends that while direct offsets are preferred, offset actions should be allowed which are indirect, diffuse and geographically remote, as long as a robust link can be demonstrated and measured between the outcomes of those actions and benefits to the particular MNES affected.

In the 2013 Scientific Consensus Statement, Schaffelke *et al.* (2013) found that there is strong evidence that improving water quality within the catchments of the GBR will contribute to enhancing the resilience of freshwater, estuarine, mangrove, coral reef and seagrass ecosystems to other disturbances. They report that water quality affects seagrass through its various biological, chemical and physical characteristics. Parameters that reduce light availability will have the greatest impact, as it is the most dominant overriding factor in seagrass growth.

Dutson *et al*. (2015) indicate that for the GBR, seagrass restoration could potentially be successful in areas where seagrass has existed in the past but a short-term impact has resulted in loss. For example, areas affected by cyclones have had seeds and mature plants physically removed, resulting in slow recovery rates. On this basis, such seagrass restoration projects may be included in future Reef Trust Investment strategies. However, in the absence of existing or currently planned Reef Trust programs to restore seagrass areas within the GBRWHA, an offset action that improves water quality by reducing sediment reaching marine environment from the Burdekin and/or Don River catchments would provide a net benefit for seagrass habitat in the region, with concomitant benefits for [among other species] marine mammals, marine turtles and commercial and non-commercial fish species.

The Reef 2050 Plan indicates that work to decrease land-based runoff in the GBRWHA waters is well advanced and, under the *Reef Water Quality Protection Plan,* significant efforts have been made by landholders, regional natural resource management organisations, agricultural industry bodies, conservation groups and government agencies to implement improved land management practices throughout the reef catchments in order to decrease the flow of nitrogen, pesticides and sediments to the Reef.

The *Great Barrier Reef Catchment Loads Monitoring Program* tracks long-term trends in water quality entering the GBR Lagoon from priority catchments, including the Burdekin River catchment, as part of the Paddock to Reef program. The program uses a combination of monitoring and modelling at paddock through to basin and reef scales. The monitoring data is used to validate the catchment water quality models that track progress towards the Reef 2050 Plan targets. The concentrations of contaminants are determined and the volume of water flowing in the rivers is then used to determine the total amount of each contaminant (including suspended sediment) that flows past the sampling sites. The loads for all measured contaminants are released in an annual technical report.

Other components of the program include paddock scale modelling and monitoring of the effectiveness of land management practices, monitoring of the prevalence of improved practices over time, catchment loads monitoring, catchment indicators, and marine monitoring.

The ability for the outcomes of this program to predict the effectiveness of particular land management practices at the management site and ultimately within the marine environment provides confidence in the ability of the management action to achieve a positive outcome that can be modelled and measured based on sound scientific methods.

The preferred strategy to offset the residual impacts of the Project is to provide a net benefit for water quality and seagrass in the GBRWHA by contributing offset/net benefit funds to actions being delivered under the existing framework that implements the strategies set out in the Reef 2050 Plan via the Reef Trust. It must, however, be ensured that those actions are delivered in the catchments that influence marine water quality and nearshore ecosystems in the region (i.e. the Burdekin and/or Don River catchments).

3.2 Proposed Reef Trust contribution

3.2.1 Sediment reduction

A contribution to catchment management actions via the Reef Trust that will prevent 150% of the fine sediment predicted to be generated by the Project, a total of 14,907t, from entering the marine environment is proposed. This metric is consistent with the Reef 2050 Plan target to achieve up to a 50% reduction in anthropogenic end-of-catchment loads of sediment in priority areas by 2025.

In the absence of an available metric for calculating an appropriate contribution to the Reef Trust to achieve water quality net benefits/offsets, it is proposed to use an assessment of the costs to institute a hypothetical (yet feasible) gully erosion management program developed in accordance with the findings of Wilkinson *et al*. (2015) and which would fit within the Reef Trust Phase II 'Investment for gully erosion control in priority grazing landscapes'. The costing is based on implementing cost-effective, effective gully remediation techniques to reduce erosion from active gullies in priority grazing landscapes (Lower Burdekin and Don catchments).

The hypothetical gully management offsets project will be defined relevant to achieving required offset outcomes of the Abbot Point Growth Gateway Project as outlined in Table 3-1.

Table 3-1 Summary and costing of advanced offset program

Program Summary	Key Benefits/Outcomes
The program will establish 'gully erosion prevention' in the Lower Burdekin / Don catchments (spatially equivalent). The proposed prevention measures are: ▪ Fencing ▪ Check dam, stick trap ▪ Grass seeding Utilising the above measures, a 50% effective capture rate is expected. Management of 228km gullies will achieve sediment reduction of 14, 907t fine sediment within the first 5 years (i.e. post establishment years 3 to 5). 15 Year Program Summary: Project capital works undertaken in Year 1. Project establishment (including maintenance and monitoring) completed in Years 1 and 2. Conservative assumption that sediment reduction is achieved from Year 3 onwards	Annual sediment reduction: 4,969t **Total sediment reduction:** **64,597t**

An appropriate offset/net benefit project would achieve the Project's sediment reduction requirements within the first five years. Given an expected 2 year establishment period, the project would be scaled to achieve (at a minimum) 14,907t fine sediment over years 3 to 5 (at 4,969t per annum).

While the Abbot Point Growth Gateway Project's offset requirements would thus be delivered within 5 years, typical infrastructure would be expected to have a design life of 15 years, and prevent a calculated 64,597t of fine sediment from leaving the catchment during that time. An appropriate offset project would be costed to be delivered, maintained and monitored over that 15 year period via the Reef Trust 'gully erosion control in priority grazing landscapes' project.

Sediment reduction achieved between years 6 to 15 are not required for project offset/net benefit and would provide a source of advanced offsets for future projects requiring sediment offsets via the Reef Trust.

The capital costs for the project would be costed by a qualified estimator. The overall sediment control project Net Present Value (NPV) incorporating capital expenditure, maintenance, monitoring and Reef Trust Administration, would be determined. The total fine sediment reduction over the fully 15 year project life (64,597t) would be taken into account to determine a $/t value for fine sediment reduction. This will in turn allow for the calculation of the required payment to the Reef Trust for the 14,907t fine sediment reduction required for the Project.

3.2.2 Seagrass net benefit

The EPBC Act Offsets Policy recognises the difficulty in achieving meaningful direct offsets for some ecological communities. Current literature (Commonwealth of Australia 2015, Wilkinson *et al.* 2015; Dutson, 2015; Schaffelke *et al*. 2013) finds that improving water quality within GBR catchments, and specifically a reduction in fine sediments entering the GBR Lagoon, will contribute to enhancing the resilience of seagrass ecosystems. The Reef Trust Phase II Investment for 'gully erosion control in priority grazing landscapes' is specifically designed to achieve improved water quality through reducing sediment entering the GBR from priority management areas.

In the absence of an accepted metric for calculating an appropriate financial contribution to the Reef Trust to offset Project impacts on seagrass, a contribution to the Reef Trust equivalent to a relevant portion of a costed seagrass enhancement of recovery and restoration program is proposed.

A proposal for a program to enhance recovery and restore seagrass at Mourilyan Harbour has been developed and costed by the James Cook University (JCU), Central Queensland University (CQU) and Griffith University Seagrass Restoration Partnership. This proposal was not developed specifically for the Abbot Point Growth Gateway Project, and is a project for which funding is currently being sought by its proponents. It should be noted that this is a real project proposal with a high level of confidence for successful reintroduction of seagrass seeds to an area that has lost seedbank following a series of extreme climatic events.

To determine the relevant financial contribution of this proposed Project to such a restoration program, calculations would need to consider the area and quality of the potential seagrass habitat impacted by the Project (i.e. 10.5ha of maximum 5% cover seagrass that would be lost through dredging of the berth pockets). This would be a conservative basis as the most recent data (December 2014) shows no seagrass present in this area.

The proposed offset/net benefit financial contribution calculation method is outlined below:

1. Determine area/quality equivalency: 10.5ha of an optimum 5% cover of deepwater seagrass from the berth pocket area is equivalent to 0.5ha of 100% cover, high productivity nearshore seagrass which would be restored by the proposed offset project.
2. Determine multiplier: A 4 times multiplier which accounts for the following components:
    a. Application of a multiplier of 2 to account for potential uncertainty in achieving 100% cover of high productivity nearshore seagrass (i.e. achieving a maximum 50% cover) at the end of the five year program.
    b. Application of a multiplier of 2 to the offset area to provide a 100% net benefit for the Project for seagrass within the GBRWHA.
    c. There is no multiplier included for a lag in temporal equivalence as there is no seagrass currently present within the berth pockets dredging area
3. Determine required 'High productivity' offset area: the total seagrass offset area is calculated as 2ha (0.5ha x 4).

4. Addition of administration costs to the program budget: Add 30% of total program cost for administration, noting that monitoring costs are incorporated into the program costs.
5. Calculation of Proportionate Cost: ratio of the costs for the restoration program to the point of the full scale restoration of seagrass (6.3ha at end of year 5 of the program) for the 2ha Project offset amount, equivalent to 31.7% of the program and administrative cost.

As there are no current or planned seagrass restoration projects targeted for Reef Trust investment, the seagrass offset contribution would fund local catchment water quality improvement actions.

3.3 Offset compliance/effectiveness summary

3.3.1 EPBC Act offset principles

Table 3-2 provides an assessment of the proposed offset strategy against the overarching principles that are applied in determining the suitability of offsets under the EPBC Act.

Table 3-2 Proposed offset strategy responses to the overarching EPBC Act offset principles

Principle	Proposed Offset Strategy
Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environmental law and affected by the proposed action	The Proponent is committed to achieving a net benefit to the GBRWHA through its proposed offset strategy in accordance with the targets and objectives of the Reef 2050 Plan (Commonwealth of Australia, 2015), by undertaking or contributing to an action that results in a reduction of the amount of sediment entering the GBRWHA from local catchments (i.e. the Burdekin River and Don River catchments) by a quantity greater than the fugitive resuspendable fine sediment generated by the Project. This action will deliver a conservation outcome that will improve or maintain the viability of seagrasses and other marine communities within the GBRWHA.
Be built around direct offsets but may include other compensatory measures	Opportunities for delivering direct offsets for seagrass are limited in that seagrasses occur in locations where physical, chemical and biological conditions are suitable. Many of the factors required for seagrass establishment cannot be manipulated and direct offsets such as those achieved through rehabilitation or restoration of ecosystems in terrestrial environments are not possible in the marine environment. Therefore, it will be necessary to indirectly offset seagrass loss through other means. It is proposed to provide a net benefit for the GBRWHA by contributing net benefit/offset funds to actions being delivered under the existing framework that implements the strategies set out in the Reef 2050 Plan via the Reef Trust. Additionally, it is proposed to ensure that those actions are delivered in the catchments that

	influence marine water quality and nearshore ecosystems, including seagrass meadows, in the region. There is a strongly established link through the literature between improved water quality, particularly a reduction in fine sediments available for resuspension, and the health of seagrasses and other marine communities.
Be in proportion to the level of statutory protection that applies to the protected matter	In the absence of an offset metric for the calculation of net benefit/offset funds for contribution to Reef Trust for the affected matter (marine ecosystems and specifically seagrass), actions that would be required to provide the most immediate and effective results for reef water quality through treatment of gully erosion in the relevant catchment/s to prevent 150% of the fine sediment generated by the Project from reaching the marine environment have been costed.
Be of a size and scale proportionate to the residual impacts on the protected matter	
Effectively account for and manage the risks of the offset not succeeding	Wilkinson *et al*. (2015) predicted that the Lower Burdekin and Don management units contribute a combined 173,000tpa of fine sediment to the GBR coast and estuaries. Dougall *et.al*. (2014) reported a 15.8% reduction in anthropogenic TSS load for the Burdekin region between 2008 and 2013 due to improved catchment management practice adoption. Gully-specific management is a target of the Reef Trust Phase II investment which will be used to implement low-cost, effective gully remediation techniques to reduce erosion from active gullies in priority grazing landscapes. The predicted sediment contribution from gully erosion that could be prevented through gully management practices has a high expectation of success, and a low risk of not succeeding, in reducing fine sediment loads to the GBR.
Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action	Projects funded by the Reef Trust build on, but do not duplicate, existing Australian and Queensland Government programs and actions being delivered across the reef regions by natural resource management bodies, industry, landholders and the community.
Be efficient, effective, timely, transparent, scientifically robust and reasonable	It is assumed that projects funded via the Reef Trust mechanism would achieve these requirements to the satisfaction of DoE.
Have transparent governance	

arrangements including being able to be readily measured, monitored, audited and enforced	

3.3.2 Offset effectiveness

This section provides a summary assessment of the proposed offset against the recommendations of Bos *et.al.* (2014) for improving the effectiveness of marine offsets for the GBRWHA.

3.3.2.1 Adherence to mitigation hierarchy

Recommendation 1: Proponents be required to follow and document their adherence to the mitigation hierarchy, which considers offsets only as a last resort after avoidance and mitigation.

The avoidance and mitigation measures for the Project are set out in the draft EIS. The Project has eliminated the need to dispose of dredged material offshore in the GBRMP and GBRWHA. This has been done taking into account the guiding principles contained in the *World Heritage Convention*, the *Convention on Migratory Species* and the *Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972*.

For example, in the establishment of the Project it was determined essential that a CSD be used as this would significantly improve sediment suspension and plume impacts on water quality, in comparison to other dredging techniques.

Impacts associated with the Project are anticipated to be contained in the immediate vicinity of the Project. The ecological and World Heritage Area values within the project area will be maintained through the application of appropriate management, mitigation and, as a last resort for impacts that cannot be completely eliminated or mitigated, net benefit/offsetting measures. The objective of maintaining or enhancing the existing ecological processes of areas within, and adjacent to, the Project has been a key consideration.

While the Project has been designed to ensure least possible impact on MNES and impact assessment predicted no significant residual impacts for MNES as a result of the Project, there are residual impacts associated with water quality and seagrass loss for which actions are warranted to ensure there is a net benefit from the Project for the GBRWHA.

3.3.2.2 Offsetability

Recommendation 2: Proponents and regulators consider the risk of offsetability prior to offset design.

Bos *et al*. (2014) developed an offsetability risk assessment, adapted specifically for the GBRWHA. Using this method as a guide, the offsetability risk for the ecological communities affected by the Project through direct removal of seagrass and water quality impacts from the introduction of suspended sediment to the marine ecosystem at the project location is determined to be predominantly low (Table 3-3). The exception is for threats to the ecosystem type particularly as in the Abbot Point context the deepwater seagrass community is recovering from a series of cyclones and flooding impacts, where the threat risk is determined to meet the criteria for medium.

3.3.2.3 Net benefits

Recommendation 3: The Australian Governments require offsets to achieve additional, measureable net benefits, relative to the counterfactual baseline, for all affected values (biodiversity and other World Heritage values).

In the 2013 Scientific Consensus Statement, Schaffelke *et al.* (2013) found that there is strong evidence that improving water quality within the catchments of the GBR will contribute to enhancing the resilience of freshwater, estuarine, mangrove, coral reef and seagrass ecosystems to other disturbances.

The preferred strategy to offset the residual impacts of the Abbot Point Growth Gateway Project is to provide a net benefit for water quality and seagrass in the GBRWHA by contributing offset/net benefit funds to actions being delivered under the existing framework that implements the strategies set out in the Reef 2050 Plan via the Reef Trust within the catchments that influence marine water quality and nearshore ecosystems in the region (e.g. the Burdekin and/or Don River catchments).

While the net benefit of the funded catchment management actions may not be specifically measured within the GBRWHA Lagoon, there is sufficient scientific evidence that reductions in fine sediment entering the marine environment from GBR catchments results in improved resilience of marine ecosystems. The *Great Barrier Reef Catchment Loads Monitoring Program* tracks long-term trends in water quality entering the GBR Lagoon from priority catchments, including the Burdekin River catchment, as part of the ‘Paddock to Reef’ program. The program uses a combination of monitoring and modelling at paddock through to basin and reef scales. Other components of the program include paddock scale modelling and monitoring of the effectiveness of land management practices, monitoring of the prevalence of improved practices over time, catchment loads monitoring, catchment indicators, and marine monitoring.

The actions funded through the proposed contribution to the Reef Trust will form a component of catchment management actions that are underway and/or planned to improve GBRWHA water quality, with rigorous modelling and measurement methods in place.

3.3.2.4 Third party offset delivery

Recommendation 4: Specialist third parties design and implement marine offsets.

The design and implementation of the appropriate catchment management actions would be the responsibility of the organisations/programs funded by the Reef Trust.

3.3.2.5 Direct offsets

Recommendation 5: Offsets are direct and specific to the affected values, with very minimal investment into research.

The allocation of funds for the appropriate catchment management actions and any necessary research would be the determined by Reef Trust and delivered by organisations/ programs funded by the Reef Trust.

3.3.2.6 Offset consolidation

Recommendation 6: Offsets are consolidated into strategic implementation sites, with long-term legal protection, that are consistent with the zoning of the GBRMP and adjacent coastal land uses.

The catchment management actions would be located with the Burdekin and/or Don River catchments to ensure that the downstream benefits are relevant to the Abbot Point area. The contribution to the Reef Trust for catchment management actions would be applied to strategic locations for management actions identified by the Reef Trust Investment Strategy. Phase II Reef Trust investments focus on reducing nitrogen and sediment runoff into the Reef and continued control of coral-eating crown of thorns starfish, complementing and building on existing actions being delivered across the reef regions by all levels of government, industry, landholders and the community.

3.3.2.7 Temporal equivalence

Recommendation 7: The time between impact and net benefit should be minimised, and net benefits should be maintained in perpetuity.

The Project construction and operation period is short-term (<2 years), although the residual impacts of suspended sediment and seagrass loss have longer-term impacts.

Impact assessment found that the loss of 10.5ha of potential sparse and ephemeral seagrass habitat of a total area of 27,757ha potential seagrass habitat mapped within the Abbot Point Area and the contribution of 9,938t of fine sediment to the immediate environment would not result in a significant impact for any threatened species, or for the health of this section of the GBRWHA in general ecological terms. As such, the timing between impact and net benefit for this Project is not critical.

It is understood that there are currently no Reef Trust projects providing opportunity for contribution to advanced offsets to reduce or eliminate the time between impact and net benefit.

'Gully erosion control in priority grazing landscapes' has been put forward in the Reef Trust Phase II investments. Wilkinson *et al*. (2015) reported that gully erosion contributes approximately 40% of all fine sediment to the GBR Lagoon, and that by comprehensively addressing known erosion hotspots, the implementation of prescribed gully erosion management measures would provide more certainty that sediment load reductions will be achieved.

The long-term maintenance of measures implemented via the Reef Trust is the responsibility of the Reef Trust. With maintenance, these measures would continue to deliver sediment reduction outcomes and provide opportunities for future advanced offsets for other projects within the GBRWHA.

3.3.2.8 Offset implementation costs

Recommendation 8: That proponents pay the full cost of offset implementation, monitoring and evaluation, and cost is agreed upon before the development is approved.

The offset/net benefit contribution will be been calculated incorporating fully costed offset implementation, monitoring and evaluation for the period required to meet the sediment offset total. These costings will be prepared to determine an appropriate contribution amount to the Reef Trust in the absence of a suitable metric for financial offset calculation.

3.3.2.9 Offset monitoring

Recommendation 9: Monitoring of the efficacy of offsets is separate to but coordinated with regional monitoring for ecosystem health, and monitoring data are made publically available.

As the offset contribution would be provided to the Reef Trust, the monitoring of the efficacy of the project/s sponsored by the Reef Trust would be subject to the paddock, catchment and marine water quality monitoring and modelling programs currently in place, the results of which are published regularly.

Table 3-3 Offsetability risk summary

	Low risk	Medium Risk	High Risk	Assessment
Condition of the value at the project site	Value is already reduced or degraded	Value is in moderate condition	Value is in good to very good condition	There will be a direct impact on 10.5ha of potential deepwater seagrass habitat in the berth pockets. The most recent surveys in December 2014 found no seagrass was growing in this area (McKenna and Rasheed, 2014a). **LOW RISK**
Affected proportion or abundance or geographic extent in the GBRWHA	<1% within GBRWHA	1% to 10% within GBRWHA	>10% within GBRWHA	The 10.5ha of potential seagrass habitat removed via dredging of the T0 berth pockets represents <0.04% of the available seagrass habitat in the Abbot Point area. **LOW RISK**
Global abundance or geographic extent	Value is globally abundant and/or present across a very large geographic extent	Value is abundant in multiple geographic regions	Value is endemic to or only remains in the impact site	There are at least 30,000km^2 of seagrass habitat in deepwater areas (>10 m) of the GBR Lagoon alone, with vast meadows also in the Torres Strait. (https://research.jcu.edu.au/tropwater/research-programs/seagrass-ecology-1/understanding-the-dynamics-of-deep-water-seagrasses-how-deep-how-meaningful) **LOW RISK**
Scale of impact on value compared to normal variation	Predicted residual impact to value is negligible when compared to range of normal inter-annual variability in	Predicted residual impact to value is on the same scale as normal inter-annual variability in abundance or	Predicted residual impacts to value is greater than normal inter-annual variability in abundance or extent	The loss of 10.5ha of potential seagrass habitat is negligible when compared to the range of normal inter-annual variability in abundance or extent. For example, total meadow area of the offshore meadows of Abbot Point was different between the 2008 and 2013 wet season surveys with offshore meadow area declining by approximately 11,482 ± 2,660 ha (60%) from 2008 to 2013. By the dry season of

	Low risk	Medium Risk	High Risk	Assessment
	abundance or extent	extent		2013 total meadow area had recovered to be similar to that in 2008 (McKenna and Rasheed, 2014b). **LOW RISK**
Vulnerability of the value to impacts other than the proposed development across the wider Asia-Pacific region	Value is not threatened or known to be declining in the Asia-Pacific region	It is uncertain if the value is threatened or declining the Asia-Pacific region and/or evidence exists that the value may soon be threatened, endangered, or declining in the Asia-Pacific region	Value is threatened or known to be declining in the Asia-Pacific region	It is uncertain if the value is threatened or declining the Asia-Pacific region and/or evidence exists that the value may soon be threatened, endangered, or declining in the Asia-Pacific region. In the Abbot Point context the deepwater seagrass community is recovering from a series of cyclones and flooding impacts. **MEDIUM RISK**
Resilience of value (both resistance to impact and ability to recover after impact)	Value exhibits high resilience	Resilience is unknown or variable	Value exhibits low resilience	The deepwater seagrass community at Abbot Point is dominated by *Halophila* sp. The following is a direct quote from McKenna *et al* (2015). ‘*Halophila* species are generally small bodied opportunistic seagrasses that exhibit fast growth habits, are considered well adapted for recovery after disturbance events and are able to exploit resources under high light conditions, but are quick to disappear when light levels deteriorate (Longstaff *et al*. 1999; McMillan 1991; Hammerstrom *et al*. 2006; Ralph *et al*. 2007). Disturbance experiments at Abbot Point demonstrated that *Halophila* spp. can recover quickly (approximately three months) through a combination

	Low risk	Medium Risk	High Risk	Assessment
				of sexual and asexual reproduction and were capable of complete meadow turnover of biomass within 10 days based on productivity measurements (Unsworth *et al*., 2010; Rasheed *et al*., 2014). *Halophila* species typically produce large seed banks; 134 - 13,500 m^2 (McMillan, 1988; Hammerstrom *et al*., 2006) from which recovery can occur.' **LOW RISK**
Community and cultural dependence on value	Affected people have low levels of dependence on the ecosystem goods and services underpinned by the value. Access to ecosystem services is not a critical factor in determining livelihoods of affected communities.	People are affected by variability (e.g., some individuals in the community are highly dependent on the value, while many others are not).	The level of affected people's dependence on the associated ecosystem goods and services is very high (e.g. a local community relies on these services to meet their basic and fundamental needs); the value is of very high social or cultural significance	The deepwater seagrass community is likely to provide community value via the fisheries value it supports. The deepwater seagrass removed in the berth pockets currently does not exist and when exists is sparse and ephemeral with a maximum percentage cover in a good growing year of 5%. This deepwater seagrass community is well represented outside the berth pocket and represents <0.04% of the available habitat. No impact to community values (via fisheries) is predicted. **LOW RISK**

4 Relationship Between EPBC Act And Queensland Offsets

The Queensland *Environmental Offsets Act 2014* (Offsets Act) requires an environmental offset to counterbalance a significant residual impact of a prescribed activity on a prescribed environmental matter.

Dredging is a prescribed environmental activity as:

a) It is an environmentally relevant activity requiring and Environmental Authority under the Queensland *Environment Protection Act 1994*

b) Under Section 207 of the Queensland *Environment Protection Act 1994*, a condition imposed on an Environmental Authority or draft Environmental Authority may require or otherwise relate to an environmental offset (an environmental offset condition).

Seagrass is a prescribed environmental matter under the Offsets Act in that under the *Environmental Offsets Regulation 2014* a marine plant within the meaning of the *Fisheries Act 1994* is a matter of state environmental significance (MSES).

The Offsets Act seeks to promote coordination with Queensland offset policies and the requirements of the Australian Government providing that, to avoid duplication between jurisdictions, the Queensland Government can only impose an offset condition in relation to a prescribed activity if the same, or substantially the same impact, and the same, or substantially the same, matter has not been the subject of assessment under Commonwealth legislation, including the EPBC Act.

The Project has been declared a controlled action and is subject to assessment via an EIS under the EPBC Act. The EIS Guidelines and Statement of Reasons for the assessment approach indicate that the relevant matters to be assessed under the EPBC Act are: World Heritage properties, National Heritage Places, listed threatened species and communities, listed migratory species, Commonwealth Marine Areas and the GBRMP. Assessment of the Project impacts to World Heritage values includes the following matters:

- Water quality of the GBR (consistent with the Reef 2050 Plan)
- Habitat important for the conservation of biological diversity in a World Heritage property (specifically seagrass impacts).

There are direct links between the targets and actions as set out in the Reef 2050 Plan for water quality and [amongst other things] the productivity of fish habitats such as:

> *"Improving the quality of water entering the World Heritage Area is pivotal in supporting the Reef's values as well as in maintaining its fundamental contribution to the wider Australian community through tourism and food production. It builds resilience in areas which support significant biodiversity and species of conservation concern such as turtles and Dugongs, and drive fisheries productivity. It is also likely to reduce the frequency of future crown-of-thorns starfish outbreaks, with one line of evidence suggesting these are driven by elevated concentrations of nutrients. Actions include implementing innovative management approaches through the Reef Trust for improving water quality. 2020 targets for water quality are in line with the Reef Water Quality Protection Plan and*

include up to a 50% reduction in anthropogenic end of catchment loads of sediment by 2025."

Accordingly, the Australian Government's assessment of the impacts of the project under the EPBC Act EIS process includes:

- Substantially the same impact as the impact for MNES, i.e. the loss of seagrass as a resource for all reliant species in relation to biological diversity and ecological values (including for MNES species), and the loss of seagrass habitat for a specific suite of species, that is those species subject to commercial fisheries (MSES)
- Substantially the same matter, i.e. seagrass as a resource for all species within the GBRWHA ecosystem, and specifically for MNES species, and seagrass as a fisheries resource (MSES).

On this basis, there would be no requirement to provide any further offset for seagrass under Queensland legislation.

5 Summary of Proposed Offset Strategy

5.1 Background

The Abbot Point Growth Gateway Project (APGG Project) is proposed to support the development of Abbot Point in a manner that protects the Great Barrier Reef and the Caley Valley Wetland. The Queensland Department of State Development is the proponent for the Project and has implemented the principles of Ecologically Sustainable Development in Project planning through:

1. Eliminating the need to dispose of dredge material offshore in the GBR Marine Park and World Heritage Area
2. Using onshore areas that are already disturbed
3. Maximising the beneficial reuse of dredged material through the application of best practice placement and material management techniques to achieve recovery of construction grade sands.

The environmental impact assessment process for the Project has determined that there are no significant residual impacts of the project on MNES, and therefore no requirement to offset impacts in accordance with the *EPBC Act Environmental Offsets Policy (2012).* However, independent of this policy, there is a requirement to achieve a net benefit through offsetting impacts that cannot be avoided or mitigated within the GBRWHA. Specifically, the EIS guidelines state that the EIS must demonstrate how the proposed action will provide a net benefit for water quality in the GBRWHA consistent with the *Reef 2050 Long-Term Sustainability Plan (2015)*.

Residual impacts of the Project on GBRWHA values that cannot be avoided or fully mitigated are:

1. The exposure of 9,938t of fine sediment available for resuspension through the dredging activities
2. Permanent loss of 10.5ha of potential seagrass habitat within the proposed berth pockets.

The preferred strategy to offset the residual impacts of the Project is to provide a net benefit for water quality and seagrass in the GBRWHA by contributing offset/net benefit funds to actions being delivered under the existing framework that implements the strategies set out in the Reef 2050 Plan via the Reef Trust. It must, however, be ensured that those actions are delivered in the catchments that influence marine water quality and nearshore ecosystems in the region (i.e. the Burdekin and/or Don River catchments).

5.2 Proposed Reef Trust contribution for sediment reduction

A contribution to catchment management actions via the Reef Trust that will prevent 150% of the fine sediment predicted to be generated by the Project, a total of 14,907t, from entering the marine environment is proposed. This strategy is consistent with the Reef 2050 Plan target to achieve up to a 50% reduction in anthropogenic end-of-catchment loads of sediment in priority areas by 2025.

In the absence of an available metric for calculating an appropriate financial contribution to Reef Trust to achieve water quality net benefits/offsets, it is proposed to make an assessment of the costs to institute a hypothetical (yet feasible) gully erosion management project developed in accordance with the findings of Wilkinson *et al.* (2015) and which would fit within the Reef Trust Phase II Investment for ‘gully erosion control in priority grazing landscapes’. The costing would be based on implementing cost-effective gully remediation techniques to reduce erosion from active gullies in priority grazing landscapes (Lower Burdekin and Don River catchments).

The costed offset/net benefit program would be designed to achieve the Project’s sediment reduction requirements within the first five years. However, it is expected that gully management infrastructure would have a 15 year design life before requiring refurbishment. The project would be maintained and monitored via the Reef Trust ‘gully erosion control in priority grazing landscapes’ project.

The capital costs for the project would be costed by a qualified estimator. The overall sediment control project NPV (incorporating capital expenditure, maintenance, monitoring and Reef Trust Administration) would be determined. Taking into account the total fine sediment reduction over the entire life of the infrastructure (15 years), a $/t for value for fine sediment reduction would be determined. This $/t for value for fine sediment reduction over the infrastructure useful life would be applied to calculate the required payment to the Reef Trust for the 14,907t fine sediment reduction required for the Project.

5.3 Proposed Reef Trust contribution for seagrass

The EPBC Act Offsets Policy recognises the difficulty in achieving meaningful direct offsets for some ecological communities. Current literature finds that improving water quality within GBR catchments, and specifically a reduction in fine sediments entering the GBR Lagoon, will contribute to enhancing the resilience of seagrass ecosystems. The Reef Trust Phase II Investment for ‘gully erosion control in priority grazing landscapes’ is specifically designed to achieve improved water quality through reducing sediment entering the GBR from priority management areas.

In the absence of an accepted metric for calculating an appropriate financial contribution to Reef Trust to offset Project impacts on seagrass, a financial contribution equivalent to a relevant portion of a costed case-study for seagrass recovery and restoration program for 6.3ha of high productivity seagrass is proposed.

To determine the relevant project contribution to the restoration case study project presented in this offset/net benefit strategy, calculations consider the area and quality of the potential seagrass habitat impacted by the Project (i.e. 10.5ha of maximum 5% cover seagrass that would be lost through dredging of the berth pockets). This is considered a conservative basis as the most current data (December 2014) shows no seagrass currently present in this area.

As the restoration project case study provides for the re-establishment of high productivity nearshore seagrass while the impact location supports a potential maximum 5% cover of low productivity deepwater seagrass, comparability has been achieved by consolidating required offset in the impact area to a 0.5ha area (5% of 10.5 ha). A multiplier of x4 will be applied to account for uncertainty (x2) and the provision of an overall net benefit (x2) of the seagrass affected, requiring a 2ha area offset. A 30% administration cost will be included in the costing.

The proposed net benefit/offset contribution to the Reef Trust for seagrass impacts would be equivalent to a 2ha proportion (31.7%) of the cost of the overall (6.3ha) restoration project.

A $/ha for the cost of the restoration project case study would be determined and applied to calculate the required payment to the Reef Trust for the 2ha area offset required for the Project.

5.4 Offset/net benefit suitability and effectiveness

The proposed offsets comply with the overarching EPBC Act offset principles and are consistent with the recommendations of Bos *et al.* (2014) for improving the effectiveness of marine offsets for the GBRWHA.

There are no significant residual impacts on GBRWHA values predicted for this Project. However, the Proponent is committed to achieving a net benefit for the GBRWHA, and through impact avoidance and mitigation has ensured that the environmental outcomes are consistent with the strategies and objectives of the *Reef 2050 Long Term Sustainability Plan*. The proposed net benefit component of the Project has been developed to appropriately support the Reef Trust initiative to provide innovative, targeted investment focused on improving water quality, restoring coastal ecosystem health and enhancing species protection within the GBRWHA.

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Appendix G

Greenhouse Gas Advice Reports

Advisian
WorleyParsons Group

Queensland Government

JOINT REPORT to the Land Court of Queensland on "Climate Change – Emissions"

Adani Mining Pty Ltd (Adani) v Land Services of Coast and Country Inc & Ors

EXPERT DETAILS

Dr Chris Taylor

My business address is URS Australia Pty Ltd, Level 17, 240 Queen Street, Brisbane, QLD 4000.

I am an environmental scientist with 15 years' postgraduate experience in academic research and environmental consultancy, specialising in atmospheric emissions, preparation of emissions inventories, greenhouse gas (GHG) assessments and climate change. I hold the following qualifications:

- MChem in Chemistry (1st class) from the University of Wales, Swansea, UK
- PhD in Atmospheric Chemistry and Climate Change from the University of Reading, UK

A/Prof Malte Meinshausen

My business address is 700 Swanston Street, Level 1, Lab 14 Carlton Connect, Department of Earth Sciences, The University of Melbourne, Parkville 3010, VIC.

Summary of experience:
I am an ARC Future Fellow and Associate Professor at the University of Melbourne in the areas of climate change projections, uncertainties, carbon cycle and international climate change policy, and Director of the Australian-German College of Climate & Energy Transitions at the University of Melbourne. I hold the following qualifications:

- Diploma in Environmental Sciences (Dipl. Env. Sc.) from the Swiss Federal Institute of Technology, ETH Zurich, Switzerland.
- M.Sc. of Environmental Change & Management (Distinction) from the University of Oxford, UK.
- PhD in Climate Change & Policy from the Swiss Federal Institute of Technology, ETH Zurich, Switzerland.

INSTRUCTIONS

We have been instructed to prepare a joint expert report on greenhouse gas and climate change issues for the Land Court of Queensland hearing of objections to the grant of Adani's mining lease (ML) and environmental authority (EA) applications for the mine component (Mine) of the Carmichael Coal Mine and Rail Project (Project).

The scope of this report is the current scientific understanding of climate change, quantification of emissions from the proposed Carmichael Mine (the Mine) and the contribution of those emissions to climate change. This report does not discuss other issues, such as coal supply chain economics.

JOINT REPORT

1. The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5), published in 2013 and 2014, represents the most comprehensive scientific assessment of the causes, impacts and mitigation measures for climate change to date.

2. The Commonwealth Government report entitled The Critical Decade 2013 climate change science, risks and responses provides a comprehensive synthesis of climate change science with an Australian national focus.

3. The 2010 Queensland Government report entitled Climate Change in Queensland: What the Science is Telling Us provides a comprehensive synthesis of climate change science with a Queensland focus.

4. Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems:

    a. Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and the sea level has risen.

    b. Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide (CO_2), methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century.

c. Emissions of CO_2 from fossil fuel combustion and industrial processes contributed about 78% of the total greenhouse gas emissions increase from 1970 to 2010, with a similar percentage contribution for the increase during the period 2000 to 2010 (high confidence).

d. In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans.

5. Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks.

6. Without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risk of severe, widespread, and irreversible impacts globally (high confidence).

7. The objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to avoid dangerous interference with the climate system. To meet this objective, Australia and other parties to the UNFCCC envisaged in 2009 a goal to limit the increase in global temperatures to 2°C goal and decided in 2012 to work towards the deep emission reductions required.

8. Australia has pledged to reduce its GHG emissions by five per cent below 2000 levels by 2020. Additional, more significant cuts have been pledged depending on global action towards stable levels of GHGs in the atmosphere. All of these targets are based on net national emissions and, therefore, do not include emissions associated with fuel exported to be used by other nations. India and China, where the majority of product coal from the Mine is expected to be used, have pledged to reduce their emission intensity and/or to peak emissions. However, they have not yet pledged absolute emission reductions

or caps. Recent announcements by China only specified that Chinese national CO_2 emissions will peak before 2030, but the peak level has not been quantified – meaning that additional coal use in China until 2030 could lead to higher emissions up to 2030 and beyond. Existing and any future commitments made by India and China could cover emissions from their own national power generation and hence could affect the scope 3 emissions associated with this Mine. For example, China’s Climate Change Action Plan places a limit on coal use for primary energy supply from 2020. China is also carrying out trials of emissions trading schemes in seven cities and provinces, and is planning to implement a national emissions trading scheme to start in 2016.

9. Approaching 2ºC warming there will be significant impacts in Queensland, Australia and globally, including:

    a. In Queensland:

        i. a decline in environmental values including the Great Barrier Reef (IPCC AR5 WGII, 2014; Climate Commission, 2013, p.5 and p.74, Queensland Government, 2010, p.2);

        ii. increased flooding, erosion and damage in coastal areas due to increased numbers of severe tropical cyclones and sea level rise (Queensland Government, 2010, p.15, 25, 27, 38, 40);

        iii. significant increase in heat-related deaths and diseases (Climate Commission, 2013, p. 60-61; Queensland Government, 2010, p.66);

        iv. reduced water availability and increased frequency of droughts, affecting agricultural production (Climate Commission, 2013, p. 65); and

        v. coastal erosion due to sea level rise, projected to be about 40cm higher than today by the late 21st century (IPCC AR5 WG1, 2013).

    b. In Australia:

i. more frequent heat waves (IPCC AR5 WG1, Table SPM.1; Queensland Government, 2010, p.3); and

ii. more frequent and/or more intense droughts (IPCC AR5 WG1, Table SPM.1, Queensland Government, 2010, p.3).

c. Globally:

i. Climate change will amplify existing risks and create new risks for natural and human systems. Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development. Increasing magnitudes of warming increase the likelihood of severe, pervasive, and irreversible impacts for people, species and ecosystems. Continued high emissions would lead to mostly negative impacts for biodiversity, ecosystem services, and economic development and amplify risks for livelihoods and for food and human security. (IPCC AR5 SYR, p.24)

ii. From a poverty perspective, climate change impacts are projected to slow down economic growth, make poverty reduction more difficult, further erode food security, and prolong existing and create new poverty traps, the latter particularly in urban areas and emerging hotspots of hunger (medium confidence). (IPCC AR5 SYR, p.11)

10. As emissions of CO_2 effectively accumulate in the atmosphere it is the cumulative, not annual, CO_2 emissions that matter for long-term climate change. Thus, whether a project's emissions occur over 60 years or 5 years does not matter for end-of-century climate change or eventual peak warming; what matters are the cumulative emissions. The biophysical reason that cumulative emissions matter is the long time (many hundreds of years to thousands of years) for natural processes in the Earth's system to remove CO_2 that has been added to the carbon cycle (the atmosphere, the oceans and the land biosphere) due to human activity, such as by burning fossil fuels.

Warming caused by CO_2 emissions is effectively irreversible over multi-century timescales.

11. The expected lifetime of the Mine is 60 years. During this time it, and the power stations that it will supply, could to different extents be subject to national and international policies on GHG emissions. Thus, the full emissions associated with the mine might not be realised, if emissions are restricted such that warming is limited to 2 degrees.

12. When carrying out an assessment of the extent that the Mine causes additional cumulative emissions, the Mine cannot be viewed in isolation, but should be seen in terms of the change in global net emissions. The fundamental question that must be answered is to what extent a project or policy will result in a change in global emissions. There is a net change to global emissions to the extent emissions associated with the Mine are not offset by a reduction in emissions elsewhere, or to the extent that they would otherwise occur even if the Mine were not approved. All Emissions from the burning of product coal from this Mine will have a climate impact in the physical cause-effect sense. If those climate impacts are additional to what would have occurred in the absence of the Mine’s approval depends on the extent the Mine increases global coal consumption. The calculated cumulative emissions associated with the project, therefore, should be seen as a worst-case net change in global emissions.

13. The impacts of climate change due to CO_2 emissions from fossil fuels such as coal are effectively irreversible for the next millennium, unless measures are taken to remove CO_2 from the atmosphere. Global temperatures will not fall significantly from their peaks for at least a millennium due to CO_2 emissions this century. Induced rises in sea level are even likely to continue to increase over that time period, unless CO_2 is removed from the atmosphere.

14. There are multiple mitigation pathways that, if implemented, would be likely to limit warming to below 2°C relative to pre-industrial levels. These pathways would require substantial emissions reductions over the next few decades and near zero net emissions of greenhouse gases by the end of the century. This

would require negative net CO_2 emissions to offset the remaining positive non-CO_2 greenhouse gases by the end of the century.

15. A global carbon budget of no more than about 1,000 gigatonnes of CO_2 is still available after 2011 in order to stay under the 2°C climate limit with a likely chance (66% likelihood or higher). Assuming at least 2010 emission levels of 37 gigatonnes CO_2 of total CO_2 emissions for the years 2012-2015, the remaining carbon budget for after 2015 is 850 gigatonnes CO_2.

16. Exploitation of the current proven reserves of coal could result in emissions of approximately 4,000 to 7,000 gigatonnes of CO_2 which would vastly exceed 2°C warming, unless carbon capture and storage becomes viable.

17. Dr Taylor has recalculated emissions from the Mine using updated emissions factors from the National Greenhouse Accounts Factors where appropriate. Dr Taylor has also estimated Scope 3 emissions associated with the Mine using the assumptions detailed in Annex 1. Scope 3 emissions include transport by rail, shipping and combustion of the product coal. Scope 1, 2 and 3 emissions are presented in Table 1. Prof. Meinshausen has calculated emissions from the burning of product coal using its estimated average ash content, moisture content and carbon content. Full assumptions are shown in Annex 1. The calculated total of 4.49 gigatonnes CO_2 is consistent with Dr Taylor's calculations of 4.64 gigatonnes CO_2, which include emissions from rail and shipping of the product coal.

Table 1 – Scope 1, 2 and 3 emissions associated with the Mine

Scope	Annual average emissions (tCO_2-e)	Life of mine emissions (tCO_2-e)
Scope 1	628,723	37,723,358
Scope 2	808,898	48,533,904
Scope 3	77,395,516	4,643,730,979
Scope 1+2	**1,437,621**	**86,257,262**
Scope 1+2+3	**78,833,137**	**4,729,988,241**

18. Using the above estimates, the cumulative emissions proposed to be authorised are approximately 0.53-0.56% of the carbon budget that remains after 2015 to have a likely chance of not exceeding 2 degrees warming.

19. As noted above, this is an estimate of a worst-case or maximum impact on net global emissions. The change in net global emissions would depend on the net change in global coal consumption resulting from the approval of the Mine, whether carbon sequestration and storage technology is used when burning the coal, and whether the projected amount of coal would be produced over the course of the lifetime of this mine or limited before its end-of-lifetime (e.g. due to new climate policies).

20. Although cumulative emissions are important for assessing the Mine, it is significant that these emissions will occur over at least 60 years. At current global emission rates (that is assuming no further growth in emissions) the stated global carbon budget would be exceeded approximately 20 years from now, by which time less than one third of the calculated cumulative emissions associated with the Mine would have occurred.

21. Current international pledges to reduce emissions are insufficient to achieve the stated goal of limiting warming to 2 degrees. Therefore, if this goal is to be achieved, significant changes in national and international policies and practices relating to GHG emissions would be required during the life of the Mine. If these occur, the Mine and the power stations that it supplies could potentially be subject to the resulting national policies and legislation e.g. by implementing carbon capture and storage, revoking operation licenses or setting economic incentives to discontinue operation. Any emissions associated with the Mine could, therefore, be regulated under these policies, the production could be limited and/or the emissions could form part of the global emissions that would be released before the 2 degree warming threshold is crossed. Approval of the Mine, therefore, could be either consistent or inconsistent with the goal of limiting warming to 2 degrees, depending on a range of external factors such as coal supply chain economics, whether there is a potential premature end of the project before its end-of-lifetime, and to what

degree carbon sequestration and storage is used when burning the coal – with some factors beyond the scope of this report.

22. The cumulative emissions related to this mine (4.49 or 4.64 gigatonnes CO_2-e) are amongst the highest in the world for any individual project, and – to the knowledge of the authors – the highest in the Southern Hemisphere. Compared to the global level, annual coal production will be approximately 0.8% of global production in 2013. Associated emissions from burning the coal will be equivalent to approximately 0.2% of current global GHG emissions. The annual emissions associated with the Mine could be equivalent to approximately 14% of Australia's base year greenhouse gas emissions in the year 2000 (567 Mt). Taking into account carbon embedded in Australia's current coal and gas exports (940 Mt), this fraction would be lower, i.e. approximately 5% of base year emissions. Whilst the burning of the coal would not fall within Australia's national greenhouse accounts, the magnitude of the annual emissions associated with the burning of the coal would be equivalent to approximately three times Australia's annual emissions reduction target of 5% below 2000 levels by 2020.

Annex 1 – Emissions Calculations

A – Calculations based on the carbon content.

1. The cumulative downstream emissions authorised by the proposed Mining Lease and Environmental Authority can be estimated from average ash content, moisture content and carbon content of the product coal in addition to any emissions resulting from using coal from the overburden.

2. The assumptions for estimating downstream emissions from burning the product coal of cumulatively approximately 4.49 gigatonnes CO_2 are:

    a. Produced Product coal from the underground and opencut coal seams over the life of the mine of 720,330,921 tonnes and 1,606,215,072 tonnes, respectively (information provided by project proponent).
    b. An average ash content of approximately 24% for the underground and 31% for the opencut coal seams of this Mine (estimated from average of coal seams D, E and F (underground) and AB (opencut) in Table 4.17 Coal Seam Average Quality Results in EIS Volume 2, Document 2.04 at Table 4-16).
    c. A total moisture content of approximately 3.2% for the underground and 4.5% for the opencut coal seams (estimated from average of coal seams D, E and F (underground) and AB (opencut) in Table 4.17 Coal Seam Average Quality Results in EIS Volume 2, Document 2.04 at Table 4-16).
    d. An average carbon content on the dry ash free basis of approximately 79.2% and 78.3% for the underground and opencut coal seams, respectively (information provided by project proponent).

The above assumptions, especially those detailed under 2.b and 2.c are subject to uncertainty. However, as the agreement with the alternative estimation method in section B below shows, there is broad agreement between the two results.

B – Calculations based on the energy content.

3. Emissions may also be calculated using the expected average energy content of the product coal (21.78 GJ/kg), the volume of coal (noted above) and the National Greenhouse Accounts emission factor for coal power generation (88.43 kg CO2-e/GJ).

4. Other life of mine scope 3 emissions include:
    a. Rail transport in Queensland (updated from the EIS using 2014 emission factors) of 38,535,293 t CO_2-e
    b. International shipping of 309,375 t CO_2-e calculated assuming:
        i. average distance by sea of 4,688 nm
        ii. large cape size 220,000 DWT vessels emission factor of 2.5 g CO2-eDWT/n mile (Man Diesel and Turbo, 2014, Propulsion Trends in Bulk Carriers)
    c. Negligible emissions from rail at the destination.

Annex 2 – Areas of disagreement.

23. Dr Taylor notes that the Terms of Reference (ToR) for the Project required the proponent to:

- Provide an inventory of projected annual emissions for each relevant greenhouse gas, with total emissions expressed in 'CO_2 equivalent' terms for the following categories:
  - scope one emissions, where 'scope one emissions' means direct emissions of greenhouse gases from sources within the boundary of the facility and as a result of the facility's activities
  - scope two emissions, where 'scope two emissions' means emissions of greenhouse gases from the production of electricity, heat or steam that the facility will consume, but that are physically produced by another facility.
- Briefly describe method(s) by which estimates were made.

24. Dr Taylor notes that the ToR follow GHG accounting convention in requiring calculations of scope 1 and 2 emissions only. In Australia, reporting obligations for scope 1 and scope 2 GHG emissions are set under the National Greenhouse and Energy Reporting Act 2007 and Regulations. These require corporations that meet specified thresholds to report annually on GHG emissions, energy use and energy production. Scope 3 emissions are not reported under NGER.

25. Dr Taylor notes that an Environmental Impact Statement (EIS) was submitted in November 2012 that addressed the requirements of the ToR regarding GHG emissions. Following public notification and submissions, a supplementary EIS (SEIS) was prepared. This provided an update to estimated scope 1 and 2 GHG emissions from the Mine.

26. Dr Taylor notes that Scope 3 emissions are not reported because the organisation does not have operational control of the emissions. The scope 3 emissions of one organisation are the scope 1 or 2 emissions of another;

including scope 3 emissions would, therefore, result in double counting in the national inventory. For example, burning of the product coal is a scope 3 emission for other parts of the supply chain such as the mine and operators of the rail, port and shipping involved in transporting the coal. It is a scope 2 emission of the end-user of the electricity and scope 1 emission of the power station. Under normal carbon accounting practices, emissions from the burning of the coal should, therefore, be attributed to the power station receiving coal from the Mine.

27. In response to Dr. Taylor's statements above, A/Prof Meinshausen notes he expected inventory practices in Australia to be outside the scope of this joint report. Furthermore, A/Prof Meinshausen notes that in order to estimate climate change impacts that result from a certain project, it does not matter which scope (1, 2 or 3) the emissions are resulting from. Distinguishing among scopes can be a relevant issue when it comes to building emission inventories, but seems irrelevant when it comes to assigning potential responsibility for additional emissions to a certain project. While the operational control over the emissions could be important when it comes to sulphate dioxide emissions or other pollutants, the burning of the coal will result in basically all carbon turned into carbon dioxide irrespective of the precise burning process. Thus, any operational control over the burning process (apart from carbon sequestration and storage, CCS) does not change the ultimate amount of CO_2 emissions resulting from the produced coal. Furthermore, the resulting climate change is the same, no matter where the CO_2 emissions occur geographically, whether in Australia or overseas. The *contribution* to climate change is hence unequivocally clear in a physical cause-effect sense, i.e. that mining coal from a permanent storage (the coal mine) will ultimately lead to higher CO_2 concentrations and climate change (unless the carbon is returned to a permanent storage, e.g. via CCS again).

28. A/Prof. Meinshausen further notes that a*ttributing responsibility* of the resulting climate change to either the action of (a) getting the carbon out of the ground in the first place or to (b) burning the coal for electricity or (c) to using the fossil-fuel generated electricity for energy services seems to be a value judgement, and outside the scope of this report. All three parts of the chain,

i.e., (a) mining, (b) coal-fired electricity production and (c) fossil-fuel related electricity use, can be jointly "responsible" – but the question of responsibility is unrelated to and hence cannot be answered by a reference to inventory accounting practices in Australia.

QUALIFICATION OF OPINION

Further information regarding coal quality of the underground and open cut mines would have been useful in estimating emissions associated with the Mine. However, broad agreement between alternative calculation methods shows that this uncertainty would not affect the findings of this joint report.

EXPERT STATEMENT

We confirm the following:

- the factual matters stated in this report are, as far as we know, true
- we have made all enquiries that we consider appropriate
- the opinions stated in this report are genuinely held by us
- the report contains reference to all matters we consider significant
- we understand our duty to the court and have complied with the duty
- we have read and understood the Land Court Rules as they apply to this report
- we have not received or accepted instructions to adopt or reject a particular opinion in relation to an issue in dispute in the proceeding.

……………………………………

Chris Taylor, Brisbane, 22nd December 2014

……………………………………

Malte Meinshausen, Melbourne, 22nd December 2014

LAND COURT OF QUEENSLAND

REGISTRY:	BRISBANE
NUMBER:	MRA428-14, EPA429-14 MRA430-14, EPA431-14 MRA432-14, EPA433-14

Applicant:	ADANI MINING PTY LTD
	AND
First Respondent:	LAND SERVICES OF COAST AND COUNTRY INC.
	AND
Second Respondent:	CONSERVATION ACTION TRUST
	AND
Statutory Party:	CHIEF EXECUTIVE, DEPARTMENT OF ENVIRONMENT AND HERITAGE PROTECTION

AFFIDAVIT OF CHRISTOPHER PAUL TAYLOR

I, Dr Christopher Paul Taylor, of c/- URS Australia Pty Ltd, Level 17, 240 Queen Street, Brisbane in the State of Queensland, affirm as follows:

1 I am an environmental scientist employed by URS (in Australia and the United Kingdom) since about 2008. I have 15 years postgraduate experience in academic research and environmental consultancy, specialising in atmospheric emissions, preparation of emissions inventories, greenhouse gas (**GHG**) assessments and climate change.

2 I hold the following qualifications:

(a) Chemistry (1st class) from the University of Wales, Swansea, UK; and

Deponent

Taken by:
Solicitor / ~~Justice of the Peace~~

Affidavit
Filed on behalf of the Applicant

McCullough Robertson Lawyers
Level 11 Central Plaza Two 66 Eagle Street
BRISBANE QLD 4000
Phone: (07) 3233 8888 Fax: (07) 3229 9949
GPO Box 1855, BRISBANE QLD 4001
Ref: CEM:PWS:159359-00022

33132899v2

(b) PhD in Atmospheric Chemistry and Climate Change from the University of Reading, UK.

3 I have been engaged by McCullough Robertson, on behalf of the Applicant, to appear as an expert witness in these proceedings in relation to issues raised in the objections to the Applicant's mining lease applications and environmental authority applications for the Carmichael Coal Mine project (**Objections**).

4 My curriculum vitae is attached to the individual expert report referred to below. I refer to my curriculum vitae and say that I have provided expert evidence to a number of matters of dispute relating to GHG emissions and climate change. These include:

(a) expert report on behalf of the Applicant in the Land Court of Queensland (*Xstrata Coal Queensland Pty Ltd & Ors v Friends of the Earth – Brisbane Co-Op Ltd & Ors* [2012] QLC 013); and

(b) expert report on behalf of the Applicant in the Land Court of Queensland (*Hancock Coal Pty Ltd v Kelly & Ors and the Department of Environment and Heritage Protection (No. 4)* [2014] QLC 12).

5 I have previously prepared a joint report with Associate Professor Malte Meinshausen relating to GHG emissions and climate change issues for the proposed Carmichael Coal Mine (**GHG Joint Report**).

6 I have been further asked to prepare an individual expert report in relation to GHG emissions and climate change with regard to the Applicant's proposed Carmichael Coal Mine and any issues raised within my field of expertise due to any points of difference between experts. Exhibited to my affidavit and marked '**CT-1**' is a true copy of my report dated 6 February 2015 (**Individual Report**).

Deponent

Taken by:
Solicitor ~~/ Justice of the Peace~~

7 Pursuant to rule 428(3) *Uniform Civil Procedure Rules 1999* (Qld), I confirm that:

(a) the factual matters stated by me in the Joint Report and my Individual Report are, as far as I know, true;

(b) I have made all enquiries considered appropriate;

(c) I genuinely hold the opinions stated by me in the Joint Report and in my Individual Report;

(d) my Individual Report contains reference to all matters that I considered significant; and

(e) I understand my duty to the court and I have complied with this duty.

8 All the facts and circumstances deposed to in this affidavit are within my own knowledge except those stated to be on information and belief. I have, as required, set out the basis and source of my knowledge or information and belief.

Affirmed by Christopher Paul Taylor

at Brisbane

this 6th day of February 2015

Before me:

~~A Justice of the Peace~~/Solicitor

LAND COURT OF QUEENSLAND

REGISTRY: BRISBANE
NUMBER: MRA428-14, EPA429-14
MRA430-14, EPA431-14
MRA432-14, EPA433-14

Applicant:	ADANI MINING PTY LTD
	AND
First Respondent:	LAND SERVICES OF COAST AND COUNTRY INC.
	AND
Second Respondent:	CONSERVATION ACTION TRUST
	AND
Statutory Party:	CHIEF EXECUTIVE, DEPARTMENT OF ENVIRONMENT AND HERITAGE PROTECTION

CERTIFICATE OF EXHIBIT

Exhibit '**CT-1**' to the affidavit of Christopher Paul Taylor affirmed 6 February 2015.

Signed:
Deponent

Taken by:
Solicitor ~~/ Justice of the Peace /~~
~~Commissioner for Declarations~~

URS

Report

Dr C Taylor
Expert report to the Land Court of Queensland

AUSTRALIA

Adani Mining Pty Ltd (Adani) v Land Services of Coast and Country Inc & Ors

6 February 2015

URS

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APPENDICES

URS

1 QUALIFICATIONS AND CURRICULUM VITAE

My name is Dr Christopher Paul Taylor.

My business address is URS Australia Pty Ltd, Level 17, 240 Queen Street, Brisbane, QLD 4000.

I am an environmental scientist with 15 years' postgraduate experience in academic research and environmental consultancy, specialising in atmospheric emissions, preparation of emissions inventories, greenhouse gas (GHG) assessments and climate change. I hold the following qualifications:

- MChem in Chemistry (1st class) from the University of Wales, Swansea, UK
- PhD in Atmospheric Chemistry and Climate Change from the University of Reading, UK.

My curriculum vitae is provided at **Appendix A**.

2 MATERIAL RELIED ON IN PREPARING STATEMENT

In preparing this report I have relied on the following sources of information:

- Calculations prepared by me as detailed in my joint report with Associate Prof Malte Meinshausen dated 23 December 2014 (GHG Joint Report)
- Greenhouse Gas Protocol (2004) World Resources Institute
- Forecasts of global mean temperature increase from Climate Action Tracker (http://climateactiontracker.org)

3 BACKGROUND TO REPORT

I was not involved in the preparation of any material in support of the proposed mine. However, I have carried out additional calculations of GHG emissions associated with the project, as reported in the GHG Joint Report.

I have been engaged by McCullough Robertson, on behalf of Adani, to provide an expert report in the Land Court proceedings.

I have read the letter of instruction (provided at **Appendix B**) and I understand my duties to the Land Court as an expert witness.

I consider that I am able to provide an informed independent opinion about the matters contained within this report.

4 OPINION ON OBJECTIONS

4.1 Land Services of Coast and Country Inc.

4.1.1 Impact of the mine on climate change and ocean acidification

4.1.1.1 Land Services of Coast and Country Inc. (LSCC) states in its objection that "if the mine proceeds, there will be severe and permanent adverse environmental impacts caused by the operations carried out under the authority of the proposed mining leases". The Facts and Circumstances of the objections to the MLA and EA made by LSCC include the assertions that:

- If the mine proceeds, it will cause serious and material environmental harm by contributing to climate change and ocean acidification.
- The full extent of the serious and material environmental harm that the mine will cause by contributing to climate change and ocean acidification cannot be particularised by the objector due to the inadequate information provided by the Application in the application, EIS and SEIS.
- It has not been adequately demonstrated that the mine will not increase the likelihood, severity and longevity of the environmental harm that will result from climate change and ocean acidification.

4.1.1.2 In the GHG Joint Report I outlined the GHG assessment carried out in the EIS, which quantified Scope 1 and Scope 2 emissions from the project, as required by the Terms of Reference (ToR). I also explained that the ToR followed convention in Australian GHG reporting by not requiring an assessment of Scope 3 emissions, such as those associated with the combustion of product coal. It should also be noted that this convention is adopted internationally and is consistent with the internationally accepted Greenhouse Gas Protocol developed by the World Resources Institute. Scope 3 emissions inventories are typically prepared to help an organisation understand its value chain (upstream and downstream) emissions. As briefly outlined in the joint report, an organisation has control over its direct Scope 1 emissions; however it only has influence (rather than control) over its indirect emissions. An organisation can, therefore, exert influence over how its product is used, but under accepted carbon accounting principles, it does not take responsibility for value chain emissions.

4.1.1.3 The emission of GHG from a power station supplied by a coal mine is just one example of value chain or Scope 3 emissions. Considering other examples of value chain emissions demonstrates that it is entirely inappropriate for an organisation to take responsibility for such emissions. For example, a local petrol station would be accountable for emissions from the primary production and transport of oil, the refining process, fuel distribution and vehicle emissions from private and commercial vehicles.

4.1.1.4 The ToR and EIS approach is also consistent with EIS GHG assessments prepared for other resource projects in Queensland in recent years. By all normal GHG accounting principles, the Scope 3 emissions from the burning of product coal are and should be attributed to the power station burning the coal and not to the mine itself.

4.1.1.5 From this perspective, the impacts of the mine are those resulting from Scope 1 and Scope 2 emissions and the EIS assessment is adequate. This being the case, there was (and is) no need for the EIS to assess climate change impacts as Scope 1 and Scope 2 emissions from the mine are insignificant in a global context. As Scope 1 and Scope 2 emissions from the mine are insignificant, the mine will not cause serious and material environmental harm by contributing to climate change and ocean acidification.

4.1.1.6 The correct context for assessing Scope 3 emissions is in the assessment of cumulative impacts, referred to in the objectors Facts and Circumstances in the MLA objection as "the combined effects of the mining activity and other activities and factors". When considering cumulative impacts it is not sufficient to consider the overall magnitude of the impact. We must also understand what the contribution of a project is to that overall impact. This issue is discussed in the GHG Joint Report at paragraph 12, which states that the question of whether "climate impacts [of the mine] are additional to what would have occurred in the absence of the Mine's approval depends on the extent the Mine increases global coal consumption." In the joint report of Jon Stanford and Tim Buckley (dated 30 December 2014), Jon Stanford states that global coal demand "will not change as a result of the commissioning of the Carmichael Mine." If that is the case, then the cumulative impact or "combined effects" of the mine on climate change and ocean acidification would be negligible.

4.1.2 *Impact on Australian greenhouse gas policies*

4.1.2.1 The GHG Joint Report discusses Australian GHG emissions policies at paragraph 8 and compares Scope 3 emissions associated with the mine to Australian emissions reduction targets at paragraph 22. As stated in the joint report, the burning of the coal would not fall within Australia's national greenhouse accounts. These emissions are, therefore, irrelevant to the achievement of Australian GHG policies. The magnitude of the comparison is correct, but Australia's contribution to global GHG emissions is modest. The emissions in question would be covered by other countries' GHG budgets and related policies.

4.1.2.2 Adani has made a number of commitments, outlined in the EIS and summarised in the Coordinator-General's Report, regarding the minimisation of direct GHG emissions and those from purchased electricity. These emissions, being Scope 1 and Scope 2, are relevant to Australia's GHG policies. However, they are not significant in the context of national emissions and would not have a material impact on the national emissions reduction target.

4.1.3 *Impact on international "2 degree" target*

4.1.3.1 The GHG Joint Report discusses an international target to limit global warming to 2 degrees and, at paragraph 21, notes that the approval of the mine could be either consistent or inconsistent with this goal.

4.1.3.2 In reality, we can expect fossil fuels to play a more significant role in future energy production than suggested by the 2 degree target because that target itself appears highly unrealistic. As expressed in the joint report, international pledges to reduce emissions are insufficient to achieve the 2 degree target. Climate Action Tracker, which tracks the emissions commitments and actions of countries, suggests at the time of writing that global mean temperatures will increase above pre-industrial levels by about 3.1 ^{o}C by 2100. This estimate already takes into account GHG pledge announcements in 2014 by the EU, US and China.

4.1.3.3 As noted in the GHG Joint Report, the global emissions budget to limit warming to 2 ^{o}C will be exceeded in approximately 20 years at current rates of emissions. As global emissions are on an increasing trajectory, the budget is likely to be exceeded sooner and before one third of the calculated cumulative emissions associated with the mine would have occurred.

4.1.3.4 Any realistic scenario in which the 2 degree target is achieved still includes the continued burning of fossil fuels as the power stations that will provide the world's electricity for decades to come have already been built. Emissions from these power stations can be considered locked in. The source of their fuel will depend on market forces, but their emissions are virtually certain to occur, regardless of the exact fuel supply.

4.2 Conservation Action Trust

The Conservation Action Trust (CAT) has raised objections relating to the impact of existing and in development coal fired power stations in India on local communities. Although I have considerable experience in the assessment of emissions from power generation and industrial process, I do not have sufficient information to provide an opinion on the impact of these power stations specifically. However, it is my opinion that their impacts are not a relevant consideration for the approval of the Carmichael Coal Mine. Existing and in development power stations will obtain fuel on the international market regardless of the approval of this particular mine. Therefore, the mine will not have any meaningful impact on the health and wellbeing of communities in India.

5 SUMMARY OF CONCLUSIONS

5.1.1.1 It is my opinion that the mine will not cause serious and material environmental harm by contributing to climate change and ocean acidification. Further, it is my opinion that it has been adequately demonstrated that the mine will not increase the likelihood, severity and longevity of the environmental harm that will result from climate change and ocean acidification.

5.1.1.2 Following national and international GHG accounting principles, emissions from the burning of the product coal are the responsibility of the power station that burns the coal, not the mine. Other emissions associated with the project are not significant in a global context.

5.1.1.3 Emissions from the burning of product coal should be considered as a cumulative impact of the project with other activities. As noted in the GHG Joint Report, the cumulative impact of the mine only creates additional impacts if it results in a net change in global coal consumption. If Jon Stanford is correct in stating that global coal demand will not change as a result of the mine then the cumulative impact of the mine would be negligible.

5.1.1.4 The mine will have a negligible impact on the achievement of Australia's GHG emissions reduction policies. Emissions from the burning of product coal from the mine will not form part of Australia's inventory. Scope 1 and Scope 2 emissions, which do fall within Australia's emissions inventory, will be minimised according to commitments made by Adani and will not be significant.

5.1.1.5 The 2 degree warming target is highly unrealistic because, as noted in the joint report, international pledges are insufficient to achieve it. Fossil fuel use is locked in for the coming decades as coal fired power stations have already been built or committed to. The approval of the mine will not affect emissions from these existing and in development power stations.

5.1.1.6 It was not possible to assess the health impacts of existing or in development power stations in India. However, I do not believe this is a relevant consideration for the approval of the Carmichael Coal mine because their operation is not dependent on the mine's approval.

6 EXPERT'S CONFIRMATION

I have read and understood relevant extracts of the Land Court Rules 2010 (Qld) and the Uniform Civil Procedure Rules 1999 (Qld). I acknowledge that I have an overriding duty to assist the Court and state that I have discharged that duty.

I have provided within my report:

- details of my relevant qualifications;
- details of material that I relied on in arriving at my opinions; and
- other things as required by the Land Court Rules.

I confirm the following:

- the factual matters included in the statement are, to the best of my knowledge, true;
- I have made all enquiries I consider appropriate for the purpose of preparing this statement;
- the opinions included in this statement are genuinely held by me;
- this statement contains reference to all matters I consider significant for its purpose;
- I have not received or accepted any instructions to adopt or reject a particular opinion in relation to an issue in dispute in the proceeding.
- If I become aware of any error or any data which impact significantly upon the accuracy of my report, or the evidence that I give, prior to the legal dispute being finally resolved, I shall use my best endeavours to notify those who commissioned my report or called me to give evidence.
- I shall use my best endeavours in giving evidence to ensure that my opinions and the data upon which they are based are not misunderstood or misinterpreted by the Land Court.
- I have not entered into any arrangement which makes the fees to which I am entitled dependent upon the views I express or the outcome of the case in which my report is used or in which I give evidence.

APPENDIX A

Curriculum Vitae

Qualifications

PhD Atmospheric Chemistry and Climate Change, University of Reading, 2002

MChem, Chemistry, University of Wales, Swansea, 1999

Chris Taylor

Senior Associate Environmental Scientist

Areas of Experience

- Emissions inventories
- Greenhouse Gas assessments
- Climate Change
- Atmospheric dispersion modelling
- Emissions reduction strategies
- Air quality monitoring surveys
- Assessment of dust and odour
- Public hearings and Expert Witness

Career Summary

Chris is a Senior Associate Environmental Scientist and URS air quality team leader for Brisbane. He specialises in air quality, greenhouse gas assessments and climate change. He has extensive experience in mining, oil and gas, ports and industry across Australia, Asia, Middle East and Europe.

Projects include providing Expert Witness services in relation to the climate change impact of Xstrata's Wandoan Coal Mine and the GVK Hancock Alpha Coal Mine.

Before starting a career in consultancy, Chris undertook research into atmospheric chemistry and climate change at the University of Reading, UK.

Career Details

Mining

- Wandoan Coal Mine (QLD) - Provided Expert Witness services in the QLD Land Court on greenhouse gas emissions and climate change for a major coal mine project proposed by Xstrata.
- Alpha Coal Mine (QLD) - Provided Expert Witness services in the QLD Land Court on greenhouse gas emissions and climate change for a major coal mine project proposed by Hancock GVK. Also technical review of air quality and greenhouse gas assessments for the EIS and SEIS
- Kevin's Corner Coal Mine (QLD) - Technical review of air quality and greenhouse gas assessments for an underground coal mine development
- Red Hill Mining Lease Project (QLD) – Project manager for the EIS for an expansion of the existing Goonyella Riverside Broadmeadow mine
- Ivanhoe Osborne (QLD) – Updated EM Plan to support a licence amendment for a new Tailings Storage Facility.
- Ivanhoe Merlin Molybdenum-Rhenium Project (QLD) - Air quality input to the Feasibility Study and relevant aspects of an Environmental Management Plan
- McArthur River Mine (NT) - Air quality and greenhouse gas assessment components of an EIS for a significant mine expansion plan. Further work has included assessments of power generation options and proposed dust control technologies during the detailed design phase.

- Gove Operations Pacific Aluminium (NT) – Air quality monitoring and modelling assessment of proposed changes to the mine and port operation.

Oil and Gas

- Arrow Energy Bowen Gas Project (QLD) – Air quality assessment of a major coal seam gas project, including modelling of local scale constraints and regional scale photochemical ozone production. A greenhouse gas assessment was also prepared for scope 1 and scope 2 emissions, including loss of carbon sink capacity.
- Bow Energy (QLD) – Air quality assessment of a major coal seam gas project, including modelling of local scale constraints and regional scale impacts. A greenhouse gas assessment was also prepared for scope 1 and scope 2 emissions, including loss of carbon sink capacity.
- Dragon LNG (UK) - Air quality assessment for an application to vary an Environmental Permit for a large new Liquefied Natural Gas (LNG) terminal. Emission sources included submerged combustion vaporisers, gas-fired boiler and flare
- 4GAS LNG le Verdon (France) - Air quality impact assessment of a new LNG terminal at le Verdon, France. The assessment included modelling of operational point source emissions and the impact of construction plant and traffic
- South Hook LNG Terminal (UK) - Air quality dispersion modelling of point source emissions, examining alternative site layouts and stack heights for environmental permit application
- Shell Pinkenba Grease Plant (QLD) - Air quality monitoring advice relating to the recommissioning of a grease plant at Shell's Pinkenba Terminal, Brisbane
- Caltex Oil Refinery (QLD) - Air quality modelling to ensure regulatory compliance using TAPM and CALMET/CALPUFF
- Oil Refinery Expansion (UK) - Assessment of the impact of emissions to air from a major oil refinery expansion project. Tasks included options assessment and consideration of impacts on ecologically sensitive sites
- Bahrain Petroleum Company Refinery Gas Desulphurisation Project (Bahrain) - Air quality assessment for a US$120 million project to reduce the environmental impact of the BAPCO refinery by installing equipment to treat sour water and gases, including an additional Sulphur Recovery Unit and Tail Gas Treating Unit
- Bahrain Petroleum Company Refinery Lube Base Oil Project (Bahrain) - Dispersion modelling assessment using Aermod to examine the air quality impact of a refinery expansion to produce lube base oil
- Bahrain Petroleum Company Gas Dehydration Unit (Bahrain) - Air pollution and odour assessment of a khuff gas dehydration unit (GDU) following odour complaints, including site inspection and air quality monitoring program. Sources of atmospheric pollution included vents, flares, combustion emissions and fugitive emissions
- Total ABK HSEIA (Abu Dhabi) - TOTAL Abu Al Bukhoosh were required by Abu Dhabi National Oil Company to prepare a Health, Safety and Environmental Impact Assessment (HSEIA) and Control of Major Accident Hazards (COMAH) study for all its existing facilities and associated operations.
- Responsible for the delivery of the EIA and air quality emissions inventory and AERMOD modelling aspects of this study

Ports & Terminals

- ASEAN Ports Capacity Development (Asia Pacific) - Emissions inventory training and support for ten ports across Thailand, Philippines, Indonesia, Cambodia, Vietnam and Malaysia
- Bangkok Port (Thailand) - Rapid assessment of transport issues at Bangkok Port and an emissions inventory for road vehicles, cargo handling equipment, ocean going vessels and harbour craft

following US EPA methods. Recommendations were made for traffic and environmental management systems.

- Teesport Northern Gateway (UK) - Air quality impact assessment of a major deep sea container port, proposed by PD Teesport. The assessment included an emissions inventory and dispersion modelling of shipping, site plant emissions and the associated road and rail freight traffic.
- Cairnryan Ferry Terminal EIA - Air quality assessment of a major expansion to a passenger ferry terminal, including modelling of ship and road traffic emissions using ADMS. Additional work included representing the client at a public consultation meeting and local Council hearing and acting as Expert Witness at Public Local Inquiry.
- Port Wirral EIA (UK) - Air quality aspects of the EIA for a new dry bulk and coal import terminal on the Manchester Ship Canal, including consideration of dust control and impacts of road traffic
- Thamesport Quay Extension EIA (UK) - Responsible for the air quality aspects of an EIA for a quay extension at the Thamesport container terminal. Key issues for stakeholders were deposition of pollutants at nearby Site of Special Scientific Interest and emissions from construction and operational traffic
- Oikos Storage Ltd new oil jetty (UK) - Oikos import A1 jet fuel, which is then distributed by pipeline. In response to increasing demand there was a need to upgrade the jetty facilities to accommodate vessels of up to 100,000 DWT. The project included concept design and outline costings for various upgrade options, walkover and diving inspections of existing structures, desk-based geotechnical investigation and advice on the environmental constraints and consents required for the new structure
- Oldbury Nuclear Power Station Marine Offloading Facility (UK) - Environmental options appraisal for a new marine facility to support the construction of a new nuclear power station, working with colleagues developing concept designs, construction programme and costing. Constraints mapping, impact identification, development of mitigation and consultation with stakeholders

Other Projects

- Milford Power Gas-Fired Power Station EIA (UK) - Air quality and greenhouse gas assessments for CCGT power station, including options for a 1600MW or 2000MW plant. The air quality assessment considered stack emissions, road traffic and construction dust. A number of plant and stack design options were assessed. Issues included the effects on public health and the deposition of pollutants on sensitive habitats
- Mersey Tidal Power (UK) - sustainability scoping report and carbon lifecycle assessment for a major tidal power scheme on the Mersey Estuary
- Stanton under Bardon Air Quality Monitoring (UK) - Air quality monitoring programme for a site intended for use as a waste management facility. Managed tendering process for a continuous monitoring station for nitrogen dioxide particulates (PM_{10} and $PM_{2.5}$) and heavy metals
- Ramat Hovav Wastewater Lagoons (Israel) - Wastewater from the Ramat Hovav industrial area will be discharged to evaporation lagoons. The issue of odour nuisance as a result of the evaporation of VOCs was raised as a concern. Responsible for the dispersion modelling of the lagoon emissions in order to specify suitable effluent discharge limits
- Bahrain International Investment Park (Bahrain) - Air quality monitoring campaign and large-scale modelling study for the Hidd industrial area of Bahrain to determine the suitability of a new Investment Park for clean industry. Local sources include iron, steel and aluminium production, existing and proposed power stations, ready-mix cement, other industry and road traffic. The methodology was agreed in consultation with the General Directorate for Environment and Wildlife Protection (GDEWP)

- Biodiesel Production Facility (UK) - Responsible for the EIA and Environmental Statement, including technical delivery of the air quality and odour aspects, for a new biodiesel and glycerine production facility

Professional History

Senior Associate Environmental Scientist, URS Australia Pty Ltd, Brisbane, 2012 - present

Associate Environmental Scientist, URS Australia Pty Ltd, Brisbane, 2011 - 2012

Principal Environmental Specialist, URS Scott Wilson, UK, 2008 - 2011

Senior Environmental Consultant, Royal Haskoning, UK, 2004 - 2008

Environmental Consultant, RPS, UK, 2003 - 2004

Post-Doctoral Research Assistant, University of Reading, UK, 2002

Education and Training

PhD Atmospheric Chemistry and Climate Change, University of Reading, 2002

MChem, Chemistry, University of Wales, Swansea, 1999

APPENDIX B

Partner Peter Stokes
Writer Claire Meiklejohn
Direct line 07 3233 8760
Email cmeiklejohn@mccullough.com.au
Our reference CEM:PWS:159359-00022

Lawyers | McCullough Robertson

2 February 2015

Dr C Taylor
Senior Associate
URS

Email chris.p.taylor@urs.com

Dear Chris

Adani Mining Pty Ltd v Land Services of Coast & Country Inc. & Anor
Land Court of Queensland Proceedings no. MRA428-14, EPA429-14, MRA430-14, EPA431-14, MRA432-14 and EPA433-01Land Court of Queensland Proceedings no. MRA428-14, EPA429-14, MRA430-14, EPA431-14, MRA432-14 and EPA433-01

We refer to:

1 Mining Lease Applications (**MLAs**) 70441, 70505 and 70506 made by Adani Mining Pty Ltd (**Adani**);

2 the associated environmental authority application, as re-made on 14 April 2014;

3 the Environmental Impact Statement (**EIS**), Supplementary EIS (**SEIS**) and Additional Information to the EIS (**AEIS**) prepared for Adani and made publicly available under the *State Development and Public Works Organisation Act 1971* (Qld);

4 the draft Environmental Authority (**EA**) issued by the Statutory Party on 28 August 2011;

5 the Objection of Land Services of Coast and Country Inc (**LSCCI**) to the MLAs dated 16 June 2014;

6 the Objection of LSCCI to the EA made 10 September 2014;

7 the submission (dated 17 June 2014) and objection (dated 25 September 2014) about the EA made by Debi Goenka of the Conservation Action Trust (**CAT**);

8 the Preliminary List of Issues for the LSCCI dated 2 December 2014;

9 your joint report, with Associate Professor M Meinshausen, dated 23 December 2014 (**Joint Report**); and.

10 our letter of instruction to you dated 30 Janu2 February 2015.

Instructions

11 We require you to provide a further statement of evidence under the *Land Court Rules 2000* (Qld) (**Rules**).

12 In accordance with orders made by the Court, your further statement of evidence is required by **Friday, 6 February 2015**.

Format of report

13 When preparing the further statement of evidence, and responding to the questions dealt with in section E below, please deal with the following:

SECTION A - Qualifications and Curriculum Vitae

14 Please attach your curriculum vitae to the report.

SECTION B - Material relied on in preparing the statement

15 Lists are sufficient for the statement, it would be useful to ensure that you (and we) have a copy of all the listed material when finalising your report. In particular, you should list:

(a) all material facts, written or oral, on which the statement of evidence is based; and

(b) reference to any literature or other material relied on by you to prepare the statement.

16 It may also be necessary to review the Joint Report to ensure your lists include sources which may not be specifically identified in that report. You do not need to list material you have **not** relied on.

17 Any inspection, examination or experiment conducted, initiated or relied on by you to prepare the statement must also be described. This can be done by reference to the calculation methodology as set out in the Joint Report, with any further explanation or clarification if necessary.

SECTION C – Background to Report

18 Please set out the extent of your previous involvement with the Mine. Specifically, we would like you to:

(a) indicate whether you were involved in the preparation of any material in support of the proposed Mine and, if so, provide details of that work;

(b) confirm that you have since been engaged by McCullough Robertson, on behalf of Adani, to provide an expert report in the Land Court proceedings;

(c) confirm that you have read this letter of instruction (and attach a copy of this letter of instruction to your report), and confirm that you understand your duties to the Land Court as an expert witness;

(d) confirm that, notwithstanding your previous relationship with the Mine (if any), you consider you are able to provide an informed, independent opinion about the matters contained within your Report.

SECTION D – Opinion on objections

19 Please review the objections and respond to any issues within your field of expertise which concern the MLAs and EAs and which concern matters upon which you and Associate Professor M Meinshausen have reported upon. In this regard please note paragraph 23 of these instructions.

20 In particular, we draw your attention to the grounds in paragraphs 1 to 3, and 8, of the MLAs objections, and each paragraph of the EA application objection. All of the grounds of each objection are set out below for convenience.

MLAs objection

The application for the mining leases under the Mineral Resources Act 1989 (Qld) (MRA) for the Carmichael Coal Mine (the mine) should be refused on the basis of the considerations stated in section 269(4)(c), (f), (i), (j), (k), (l) and (m) of the MRA:

1. *If the mine proceeds, there will be severe and permanent adverse impacts caused by the operations carried out under the authority of the proposed mining leases.*
2. *If the mine proceeds, the public right and interest will be prejudiced.*
3. *Good reason has been shown for a refusal to grant the mining leases due to the risk of severe environmental impacts and the lack of scientific certainty regarding those impacts.*
4. *Taking into consideration the current and prospective uses of the land, the proposed mining operation is not an appropriate land use.*
5. *There is an unacceptable risk that will there will not be an acceptable level of development and utilisation of the mineral resources within the area applied for because the mine, if it proceeds at all, is likely to cease to be economically viable within the term of the lease, resulting in some or all of the environmental impacts without realising the full economic benefits predicted.*
6. *The Applicant does not have the necessary financial capabilities to carry on mining operations under the proposed mining leases.*
7. *If the mine proceeds, the operations to be carried on under the authority of the proposed mining leases will not conform with sound land use management.*
8. *In the alternative to grounds 1-7 above, if the applications are not refused, conditions should be imposed to address the matters raised in grounds 1-7.*

EA application objection

The application for the environmental authority for the Carmichael Coal Mine (the mine) should be refused under the Environmental Protection Act 1994 (Qld) (EPA) on the basis of the considerations stated in ss 3, 5, 171 and 191 of the EPA and other relevant considerations having regard to the subject-matter, scope and purpose of the EPA:

1. *Approval of the mine is contrary to the object of the EPA stated in s 3 because approval and construction of the mine will not protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).*

2. *Approval of the mine would be contrary to the requirement in s 5 of the EPA for the administering authority and the Land Court to perform a function or exercise its power under the Act in a way that best achieves the object of the Act.*

3. *Approval and construction of the mine would be contrary to the precautionary principle, which is a principle of environmental policy as set out in the Intergovernmental Agreement on the Environment and, therefore, part of the standard criteria for the decision.*

4. *Approval and construction of the mine would be contrary to intergenerational equity, which is a principle of environmental policy as set out in the Intergovernmental Agreement on the Environment and, therefore, part of the standard criteria for the decision.*

5. *Approval and construction of the mine would be contrary to the conservation of biological diversity and ecological integrity, which is a principle of environmental policy as set out in the Intergovernmental Agreement on the Environment and, therefore, part of the standard criteria for the decision.*

6. *Approval and construction of the mine will cause environmental harm to the character, resilience and value of the receiving environment.*

7. *Approval and construction of the mine would be contrary to the public interest.*

8. *Approval and construction of the mine will cause material and serious environmental harm.*

9. *In the alternative to grounds 1-8 above, if the application is not refused, conditions should be imposed to address the matters raised in grounds 1-8 above.*

21 We also ask you to again review and consider those 'Facts and Circumstances' relied on in support of each objection that are relevant to your field of expertise, namely:

(a) paragraphs 25 to 27 and 34 of the Facts and Circumstances in the MLAs objection; and

(b) paragraphs 25 to 27 and 29 of the Facts and Circumstances in the EA objection.

22 Your further statement of evidence should also build on the Joint Report, which sets out in detail those notified issues relevant to your field of expertise. The Joint Report also includes a detailed background and agreed commentary in relation to climate change and greenhouse gas emissions.

23 Please note that, pursuant to the Rules, your further statement may not:

(a) contradict, depart from or qualify an opinion in relation to an issue the subject of agreement in the Joint Report; or

(b) raise a new matter not already mentioned in the Joint Report.

24 In discussing those areas of disagreement noted in the Joint Report, as they primarily obtain to LSCCI's notified issues, we ask that you expand on and relate your opinion back (by reference for example to its number) to any relevant Facts and Circumstances and Grounds of the objections.

25 For example, the Joint Report discusses the policy and convention for greenhouse gas accounting and reporting in Australia and the requirements of the Terms of References for the EIS. If appropriate, the discussion of these matters can be related back the primary ground of the objections, that the Mine should be refused.

26 This discussion may occur in the context of, or by reference to, the areas of agreement in the Joint Report.

27 By way of another example, the Joint Report refers to your opinion as to reporting of emissions where the organisation does not have operational control of the emissions. If appropriate, further explanation of this can be made, again by reference (where appropriate) to the relevant grounds of the objections.

28 By way of further example, the Joint Report refers to Australia's objectives under the United Nations Framework Convention on Climate Change[1], and the target of limiting warming to 2 degrees[2]. To the extent that there are additional matters relating to these topics relevant to responding to the objections, and in respect of which you and Professor Meinshausen did not reach agreement, it is appropriate for you to opine upon your views, including:

(a) on the application of the Convention of the project and assessment of greenhouse gas emissions, including whether or not assessment of scope 3 emissions at overseas power stations (for example) would affect Australia's objectives;

(b) on whether the Mine project is consistent or inconsistent with the 2 degree target;

(c) the relevance of relative comparisons of annual emissions (scope 1, scope 2 and scope 3) from the Mine in respect to Australia's (and other significant countries') base year greenhouse gas emissions; and

(d) on expert expectations as to the likelihood of the 2 degree target being avoided, and the time frame for event proximity to this target by comparison with the Mine project lifetime.

29 We ask that you also specifically respond to the allegations made in the objections that inadequate information was provided by Adani in the EIS and SEIS in relation to climate change and greenhouse gas emissions.

30 If you have an opinion as to whether it has been adequately demonstrated that the Mine will not increase the likelihood, severity and longevity of environmental harm which may result from climate change, please include that opinion also.

31 Please address the CAT submission and objection to the extent they are relevant to your field of expertise.

32 In your further statement of evidence, the Rules also require that where:

(a) there is a range of opinion on matters dealt with, a summary of the range of opinion and the reasons why you have adopted a particular opinion be provided; and

(b) access to any **readily ascertainable** additional facts would assist you in reaching a more reliable conclusion, a statement to that effect be included.

33 In dealing with the points of disagreement in the Joint Report, and responding to the relevant Facts and Circumstances and grounds of the objections, please also specifically identify any relevant conditions of the draft EA and express your opinion as to the appropriateness of the draft condition or its relevance to the grounds of the objections.

[1] Paragraphs 7 and 8 of the Joint Report.
[2] Paragraphs 21 and 22 of the Joint Report.

SECTION E – Summary of conclusions

34 The Rules require your further statement to provide a summary of the conclusions you have reached. In our view, this is often best presented in a separate, concluding section (or at the start of the statement).

SECTION F – Expert's confirmation

35 It is important that the report you prepare be an independent report prepared bearing in mind an expert witness' overriding duty to the court. The overriding duty encompasses the following points:

(a) You have an overriding duty to assist the Court on matters relevant to your area of expertise;

(b) You are not an advocate for a party, even when giving testimony that is necessarily evaluative rather than inferential; and

(c) Your paramount duty is to the Court and not to the person retaining you.

36 An example of the type of thing that might be said in this section is as follows:

(a) *I have read and understood relevant extracts of the Land Court Rules 2010 (Qld) and the Uniform Civil Procedure Rules 1999 (Qld). I acknowledge that I have an overriding duty to assist the Court and state that I have discharged that duty.*

(b) *I have provided within my report:*

(i) *details of my relevant qualifications;*

(ii) *details of material that I relied on in arriving at my opinions; and*

(iii) *other things as required by the Land Court Rules.*

(c) *I confirm that:*

(i) *the factual matters included in the statement are, to the best of my knowledge, true;*

(ii) *I have made all enquiries I consider appropriate for the purpose of preparing this statement;*

(iii) *the opinions included in this statement are genuinely held by me;*

(iv) *this statement contains reference to all matters I consider significant for its purpose;*

(v) *I have not received or accepted any instructions to adopt or reject a particular opinion in relation to an issue in dispute in the proceeding.*

(d) *If I become aware of any error or any data which impact significantly upon the accuracy of my report, or the evidence that I give, prior to the legal dispute being finally resolved, I shall use my best endeavours to notify those who commissioned my report or called me to give evidence.*

(e) *I shall use my best endeavours in giving evidence to ensure that my opinions and the data upon which they are based are not misunderstood or misinterpreted by the Land Court.*

(f) *I have not entered into any arrangement which makes the fees to which I am entitled dependent upon the views I express or the outcome of the case in which my report is used or in which I give evidence.*

Confidentiality

37 Any report generated by you should remain in draft until such time as we are in a position to discuss the contents of the report with you. We ask that the report be kept strictly confidential as it is to be used for the purpose of obtaining legal advice or for use in legal proceedings. You are not authorised to provide these instructions or your report to any other person or party.

If you would like any further material, or have any questions, please contact us.

Yours sincerely

Peter Stokes
Partner

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INDIVIDUAL REPORT to the Land Court of Queensland on "Climate Change – Emissions"

Adani Mining Pty Ltd (Adani) v Land Services of Coast and Country Inc & Ors

EXPERT DETAILS

A/Prof Malte Meinshausen

My business address is 700 Swanston Street, Level 1, Lab 14 Carlton Connect, Department of Earth Sciences, The University of Melbourne, Parkville 3010, VIC.

Summary of experience:

I am an ARC Future Fellow and Associate Professor at the University of Melbourne in the areas of climate change projections, uncertainties, carbon cycle and international climate change policy, and Director of the Australian-German College of Climate & Energy Transitions at the University of Melbourne. I hold the following qualifications:

- Diploma in Environmental Sciences (Dipl. Env. Sc.) from the Swiss Federal Institute of Technology, ETH Zurich, Switzerland.
- M.Sc. of Environmental Change & Management (Distinction) from the University of Oxford, UK.
- PhD in Climate Change & Policy from the Swiss Federal Institute of Technology, ETH Zurich, Switzerland.

A copy of my CV is attached as Appendix A.

INSTRUCTIONS

I have been instructed to prepare an individual expert report on greenhouse gas and climate change issues for the Land Court of Queensland hearing of objections to the grant of Adani's mining lease (ML) and environmental authority (EA) applications for the mine component (Mine) of the Carmichael Coal Mine and Rail Project (Project).

The scope of this report is the current scientific understanding of climate change, quantification of emissions from the proposed Carmichael Mine (the Mine) and the contribution of those emissions to climate change. This report references the joint report that has been prepared and submitted earlier by Malte Meinshausen and Chris Taylor.

INDIVIDUAL REPORT

1. In our joint report, dated 22nd December 2014, we agreed that the overall scope 1, 2 and 3 emissions from the mine project would result in 4.73 gigatonnes of carbon dioxide (Gt CO_2) emissions over the course of the project lifetime, based on the estimate provided by the project proponent of a total of 2.3 Gt of product coal (see paragraph 17 and Table 1). In our joint report, we indicate the cumulative amount of total global CO_2 emissions that is consistent with a likely chance of staying below the international target of limiting warming to below 2°C (see paragraphs 15 and 16). Thus, the mine's emissions would equate to around 0.53% to 0.56% of the global carbon budget (see paragraph 18).

2. This individual report is in response to new research that came out after the submission of our joint report. This new research provides regional specifics to the global carbon reserves we mentioned in the joint report (paragraph 16). Furthermore, a factual clarification is provided in regard to how the annual average emissions provided in Table 1 of the joint report were calculated.

3. This new research published after our joint report was completed uses a global energy model for providing geographical detail on the carbon resources of coal, oil and gas that are left unburned, if the international community's target of staying below 2°C were to be achieved. Under such a 2°C scenario, this research by McGlade and Ekins in the international journal Nature (8th January 2014) indicates that a large proportion of coal stays in the ground in the OECD Pacific region, including Australia. Specifically, 83 Gt of coal, or 93% of current resources is unburnable and must be left in the ground in the OECD Pacific region, which includes Australia, even under the assumption of an uptake of the carbon capture and storage (CCS) technology. Without CCS, 85 Gt or 95% of the reserves are left in the ground to have a 50%:50% chance of staying below 2°C warming. A higher likelihood of staying below 2°C warming (such as a 'likely' >66% chance) would increase the fraction of carbon that has to remain in the ground.

4. In other words, this research indicates that between 2011 and 2050 only 4.5 to 6.2 Gt can be produced from OECD Pacific coal mines, which would imply that the Carmichael coal mine project with 2.3 Gt of product coal would consume 37% to 51% of this allowable coal production, if the mine's carbon were produced and emitted until 2050. Thus, given the already granted licenses for coal mining in Australia and on the basis of this more specific research into the unburnable coal in the OECD Pacific region, it can be concluded that the coal of the Carmichael coal mine project is probably to be characterised as 'unburnable' – unless the 2°C warming limit is put into question or the mining leases elsewhere in Australia with a similar amount of product coal production are ceased.

5. There is one additional issue in our joint report, which I wish to clarify. Our Table 1 refers to Annual average emissions of 77,395,516 tonnes of CO_2-e scope 3 emissions.

I should note that this value has been derived simply by dividing the overall cumulative amount of emissions of 4,653,730,979 tonnes of CO_2-e by 60 years. Given that some parts of the mining proposal refer to higher coal production numbers per year (60 Mt product coal), the annual emissions over the initial project lifetime (30 years) could be substantially higher - e.g. almost twice as high – compared to the average 60yr value in our table (up to 121 $MtCO_2$ per year).

6. In summary, limitations on coal production, not only coal burning projects, are confirmed by new research to be an essential tool for a successful implementation of the 2°C warming limit.

Reference

McGlade, C. & Ekins, P. The geographical distribution of fossil fuels unused when limiting global warming to 2°C. *Nature* **517**, 187-190 (2015).

EXPERT'S STATEMENT – ADDITIONAL FACTS

I am not aware of any further readily ascertainable additional facts that would assist me to reach a more reliable conclusion.

EXPERT STATEMENT

I confirm the following:

(a) the factual matters stated in the report are, as far as I know, true;

(b) I have made all enquiries considered appropriate;

(c) the opinions stated in the report are genuinely held by myself;

(d) the report contains reference to all matters I consider significant;

(e) I understand the duty of an expert to the court and have complied with that duty;

(f) I have read and understood the Land Court Rules 2000 on expert evidence; and

(g) I have not received or accepted instructions to adopt or reject a particular opinion in relation to an issue in dispute in the proceeding.

M. Meinshausen

Digitally signed by Malte Meinshausen
DN: cn=Malte Meinshausen, o, ou, email=malte.meinshausen@gmail.com, c=AU
Date: 2015.02.05 22:37:36 +11'00'

Malte Meinshausen, Melbourne, 6th February 2015

Appendix A

CV A/Prof. Malte Meinshausen

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Victoria, Australia

malte.meinshausen@unimelb.edu.au
Tel: +61 (0) 466988037

Education & Research

- Since Feb 2014: Associate Professor and ARC Future Fellow at the University of Melbourne, School of Earth Sciences.
- Since 2013: Director of the Australian-German College of Climate & Energy Transitions (www.climate-energy-college.org) at the University of Melbourne, launched in October 2013 under the auspices of the then current Australian Ambassador to Germany with 13 PhD students.
- Since 2011: Senior Researcher at the Potsdam Institute of Climate Impact Research, Potsdam.
- 2008-2011: Team Leader of the PRIMAP group at Potsdam Institute for Climate Impact Research.
- Since May 2006: Researcher at Potsdam Institute for Climate Impact Research, Potsdam, Germany.
- Sep 2005 – Apr 2006: Post-Doc, Guest researcher at the National Centre for Atmospheric Research, NCAR, Boulder, USA, Collaboration with Tom Wigley and Reto Knutti.
- 2002 – 2003: Doctoral courses in macroeconomics, microeconomics and econometrics at the Study Centre Gerzensee, Swiss National Bank
- Oct 2002 – Aug 2005: PhD study in the area "International climate policy and economics", Department of Environmental Sciences, ETH, Supervisor: Prof. Dieter Imboden.

- 1995 – 1999 & 2000 – 2001: Diploma course "Environmental Sciences" at the ETH Zurich. Scholarship by Studientiftung des dt. Volkes. Diploma thesis *(with distinction)* on "Long-term stratospheric chlorine loading prediction" at the Institute for Atmospheric and Climate Science, ETH Zurich, Supervisor: Prof. Thomas Peter
- 1999 – 2000: MSc Environmental Change & Management, University of Oxford, UK. MSc Thesis on "The climatic effect of temporary carbon storage under the Clean Development mechanism of the Kyoto Protocol" *(MSc with distinction)*

Professional experience

- 2008 Co-Founder of non-profit organization Climate Analytics gGmbH (www.climateanalytics.org), assisting Small Island States and Least Developed Countries with scientific and technical advice during international climate change negotiations under the UNFCCC.
- Since 2005: Scientific & Technical Advisor for German Ministry of Environment on international climate policy. Member of the German delegations to IPCC meetings and UNFCCC negotiations.
- Since 2000 Freelance consultancy for government bodies and environmental NGOs on climate policy issues

Publications

Articles in peer-reviewed journals

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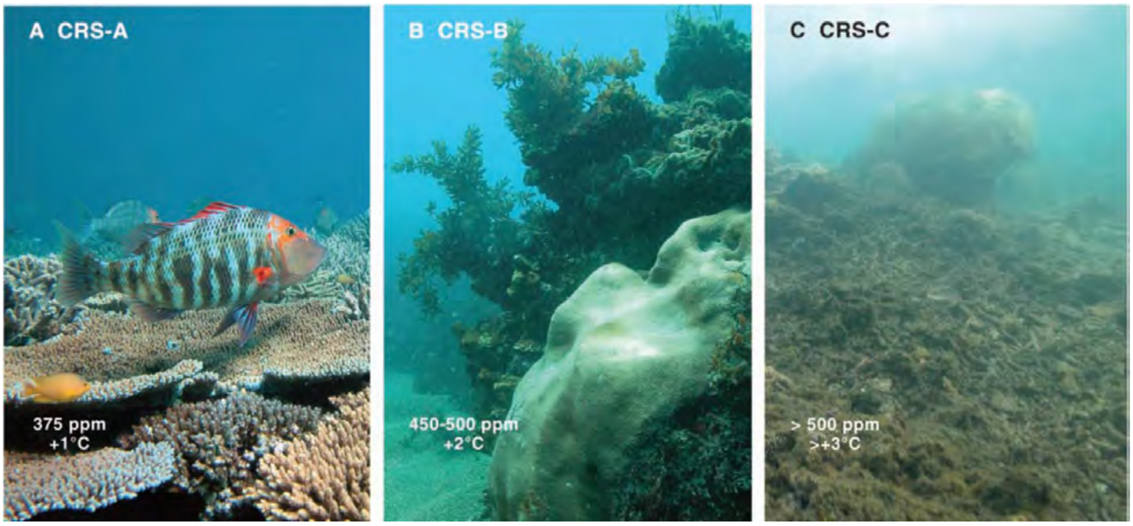
The current and future impacts of climate change and ocean acidification on the Great Barrier Reef



Report prepared for an objections hearing in the Land Court of Queensland regarding the proposed Carmichael Coal Mine

Reference numbers:
MRA428-14 & EPA429-14
MRA430-14 & EPA431-14
MRA432-14 & EPA433-14

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Director, Global Change Institute
Australian Research Council Laureate Fellow
The University of Queensland

6 February 2015

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EXECUTIVE SUMMARY

1. The Great Barrier Reef provides enormous benefits and income to the Australian people ($5-6 billion pa from tourism and fisheries). It is highly valued by the world's people, having been World-Heritage listed in 1981 and being widely recognised as one of the most pristine and valuable coral reefs in the world. It is threatened by both local (e.g. declining coastal water quality) and global factors (climate change and ocean acidification due to burning of fossil fuels), with the latter being widely recognised as the greatest threat to the health of the Great Barrier Reef. The rate at which ocean temperature and pH are changing is unprecedented in 65 million years if not 300 million years, and is having a direct impact on the health of the Great Barrier Reef and its organisms and ecosystems by driving unprecedented mass coral bleaching and mortality events, and causing calcification rates to decline in response to declining carbonate ion concentrations.

2. The Australian Government's lead agency for the protection of the Great Barrier Reef, the Great Barrier Reef Marine Park Authority (GBRMPA), recently found that climate change remains the most serious long-term risk facing the Reef and is likely to have far reaching consequences for the Region's environment. The GBRMPA also found that at present, global emissions are not on track to achieve the agreed global goal of limiting global temperature rises to beneath 2°C and even a 2°C rise would be a very dangerous level of warming for coral reef ecosystems, including the Great Barrier Reef, and the people who derive benefits from them. The GBRMPA found that to ensure the Reef remains a coral-dominated system, the latest science indicates global average temperature rise would have to be limited to 1.2°C. These conclusions are consistent with the latest available science and the most recent assessment report of the Intergovernmental Panel on Climate Change (IPCC; AR5).

3. The addition of further carbon dioxide to the atmosphere by enterprises such as the Carmichael mine will directly damage the Great Barrier Reef and reduce its ecological services, and hence the income and livelihoods of people both here in Australia and overseas. Conservative projections of climate change reveal that coral reefs like the Great Barrier Reef will be fundamentally changed into non-coral dominated ecosystem if atmospheric carbon dioxide continues to increase at its current rate. Coal mining operations such as the Carmichael mine will result in very significant impacts on Australian people and industries such as fishing and tourism. These impacts will also be felt on coral reefs, people and industries around the globe.

INTRODUCTION

4. I have been asked by Land Services of Coast and Country Inc. (LSCC) to provide an expert opinion of the likely ecological impacts of climate change and ocean acidification on the Great Barrier Reef, Australia.

5. This report has been prepared in response to that request for use in an objection hearing in the Land Court of Queensland concerning a large open-cut coal mine, the Carmichael Coal Mine, an open-cut and underground coal mine proposed to be located 160km north-west of Clermont in the Galilee Basin of central Queensland (the mine). The mining lease term applied for is 30 years; however, the expected life of the mine is 60 years.

6. The coal from the mine is proposed to be crushed, processed and blended on site before being transported by rail to the Port of Abbot Point for export to India. If it proceeds, the mine will produce thermal coal that is intended to be sold to other companies in the Adani Group to be burnt in coal-fired power stations in India to generate electricity.

7. The expected direct and indirect greenhouse gas emissions from the mining, transport and burning of the coal from the mine are 4.729 gigatonnes of carbon dioxide (Gt CO_2) according to the Joint Expert Report on Climate Change – Emissions prepared by Dr Malte Meinshausen and Dr Chris Taylor, dated 22 December 2014.

8. For the purposes of preparing this report, in addition to the Joint Expert Report on Climate Change – Emissions, I have been provided with a copy of the objection lodged by LSCC to the coal mine proposed by the applicant the subject of the appeal. I am instructed that the environmental impact statement prepared for the mine does not contain any analysis of the impacts of climate change or ocean acidification on the Great Barrier Reef (or any other ecosystem).

RELEVANT EXPERTISE

9. I am a Professor of Marine Studies and the Director of the Global Change Institute at The University of Queensland and Deputy Director of the Australian Research Council (ARC) Centre for Excellence for Reef Studies. I am also a Fellow of the Australian Academy of Science, as well is holding a prestigious Australian Research Council Laureate Fellowship. My fields of research and professional interest include:

   (a) coral reefs and marine studies;

   (b) the effects of climate change (particularly ocean warming and acidification) on reef-building corals, tropical coral reefs and related marine ecosystems;

   (c) coral bleaching and mortality, and their connection to global warming and ocean acidification;

   (d) biology of symbiotic associations in reef-building corals and the impacts of stresses such as global warming upon these associations.

10. Appendix 1 to this report provides a copy of my resume.

11. In preparing my report I understand my duty as an expert witness before the Court based on rule 24C of the *Land Court Rules 2000* is to assist the Court. While I appear pro bono to assist the Court in these proceedings, I note also that my duty to assist the Court would override any obligation I may have to any party to the proceeding or to any person who is liable for my fees or expenses.

GREAT BARRIER REEF

12. The Great Barrier Reef is one of the world's largest and most spectacular coral reef ecosystems. Lining almost 2,100 km of the Australian coastline, the Great Barrier Reef is the largest continuous coral reef ecosystem in the world. It is home to an amazing variety of marine organisms including 6 species of marine turtles, 24 species of seabirds, over 30 species of marine mammals, 350 coral species, 4,000 species of molluscs and 1,500 fish species. The total number of species number into the hundreds of thousands. New species are described each year, and some estimates suggest we are familiar with less than 50% of the total number of species that live within this amazing ecosystem. The intergenerational benefits from the sustainable management of Great Barrier Reef are enormous.

13. The Great Barrier Reef is also considered to be one of the most pristine ecosystems, which is a consequence of a relatively low human population pressure (as compared to other regions like Indonesia where tens of millions of people live directly adjacent to coral reefs) and a modern and well-resourced management agency, the Great Barrier Reef Marine Park Authority (GBRMPA), which practices state-of-the-art, science-based environmental management. The Great Barrier Reef Marine Park was established in 1975 by the Federal Government and was proclaimed a World Heritage Area in 1981 (Figure 1).

14. The Great Barrier Reef provides enormous economic value to Queensland through its fisheries and tourism industries. Estimates of its value range between $5-6 billion each year, with $5.2 billion in value added and about 64,000 FTEs generated by the tourism sector (Deloitte Access Economics, 2013). Fisheries associated with the Great Barrier Reef earn $193 million each year (ibid). These industries are largely sustainable, and represent annual contributions to the Queensland and Australian economies *ad infinitum*.

THREATS TO THE LONG-TERM SUSTAINABILITY OF THE GREAT BARRIER REEF

15. Coral reefs like the Great Barrier Reef are threatened by both local (e.g. water quality, coastal degradation, pollution and fishing pressure) and global (e.g. global warming, ocean acidification) stressors. These two categories of stress are distinguished in terms of whether particular stresses acting on a coral reef arise from 'local' sources such as a fishing industry or coastal land-use, or from global sources which arise from changes to the Earth's atmosphere and climate. Both local and global factors have already had major impacts on coral reefs. For example, the over-exploitation of coral reef species in many countries has led to the major decline in key fish species on coral reefs (e.g. herbivorous fish) which have led in turn to major changes in the ecological structure of coral reefs (Jackson et al. 2001). The major decline of reef-building corals on Caribbean reefs over the past 40 years (from >60% of the reefs covered in corals in 1970 to less than 10% coral cover

today; Hughes 1995) has been mainly attributed to the removal of herbivorous fish and the input of waste nutrients by over-populated coastal regions.

16. While overexploitation has affected some parts of the Great Barrier Reef, there is a general perception that the main threats to the Great Barrier Reef stem more from reduced water quality (i.e. increased nutrients and sediments) as a result of agricultural activities and deforestation in coastal Queensland as opposed to the fishing of herbivorous species at unsustainable levels (which does not occur to any real extent). Agricultural activities have resulted in a tenfold increase in the flux of sediments (and probably nutrients) down the rivers of Queensland starting soon after the arrival of European farmers, hard-hoofed cattle and coastal agriculture (McCulloch et al. 2003). The increased nutrient and sediment levels flowing out of these disturbed river catchments and coastal areas in Queensland is most likely to have driven some of the loss of inshore Great Barrier Reef coral reefs (i.e. first 1–5 km of coastal reef system).

Figure 1 Map of the Great Barrier Reef Marine Park (courtesy of GBRMPA)

CLIMATE CHANGE AND OCEAN ACIDIFICATION

17. Human driven changes to the greenhouse gas content of the atmosphere (principally carbon dioxide (CO_2) and methane) have driven changes to the average temperature of the planet (see pages 4-6 of the Joint Report by Taylor and Meinshausen). Over 90% of the extra heat trapped by the enhanced greenhouse effect has been absorbed by the oceans. These changes have resulted in rising ocean heat content and increases in the temperature of the upper layers of the ocean (IPCC 2007; 2014). Sea surface temperature of the global ocean has increased by about 0.5^{o}C during the 20th century. The global average warming over the past 50 years is about 0.1^{o}C per decade in the surface and decreases to 0.017^{o}C per decade at 700 m (Levitus et al., 2009). Changes are greatest in the northern hemisphere and at high latitudes (Levitus et al., 2009). As a result, the Great Barrier Reef waters are 0.4°C warmer than they were 30 years ago (Lough 2007).

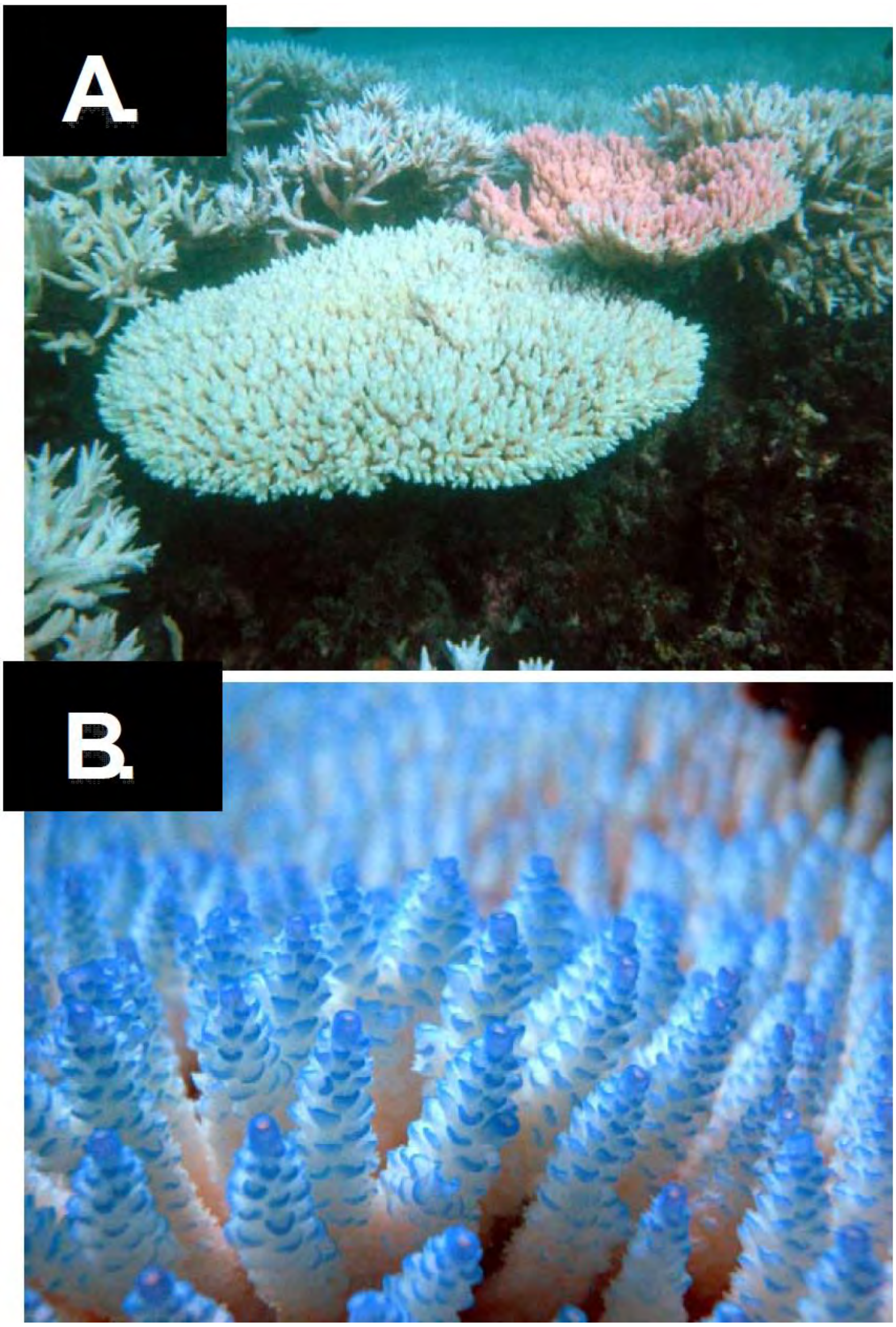
18. A large portion of carbon dioxide that is emitted into the atmosphere by burning fossil fuels is absorbed into the oceans (approximately 30%) and reacts with seawater to produce more acidic conditions, a process known as "ocean acidification" (Figure 4). This process is commonly unrecognised in public discussions about climate change and has been called "the evil twin" of climate change (Pelejero et al. 2010). Although it will be hard to quantify the effects separately, and indeed their synergistic behaviour, evidence gathered over the last years suggests that ocean acidification could represent an equal (or perhaps even greater) threat to the biology of our planet (Pelejero et al. 2010). Increasing atmospheric carbon dioxide from past human activities has also resulted in 0.1 pH decrease (i.e. the ocean has become more acidic) which has removed 30–40 μmol kg^{-1} carbonate ions from ocean bodies like the Coral Sea that normally contain between 250–300 μmol kg^{-1} (Hoegh-Guldberg et al 2007; IPCC 2013). As carbonate ions form the substrate for calcification, the decrease in carbonate ions impacts the ability of many marine organisms to form their skeletons which is ultimately crucial to the construction and maintenance of coral reefs (Kroeker et al. 2013; Hendriks et al. 2009; Kleypas and Langdon 2006; Kleypas et al. 2006; Raven et al. 2005).

19. In addition to the size of the absolute change from climate change and ocean acidification, global conditions have varied at unprecedented rates of change. Changes in atmospheric carbon dioxide (hence carbonate ion concentrations in the oceans) and sea temperature has increased at rates that are 2–3 orders of magnitude faster than the majority of changes that have occurred over the past 420,000 years at least (see Table 1 in Hoegh-Guldberg et al. 2007). The latest Intergovernmental Panel on Climate Change (IPCC) assessment report (AR5) has extended this analysis and has concluded via consensus that the current rate of change in pH and associated variables is the highest in 65 million years, if not 300 million years (IPCC 2014).

20. These changes in the conditions surrounding coral reefs have already had major impacts on coral reefs. Short periods of warm sea temperatures, once probably harmless but now riding on top of higher sea temperatures due to climate change, have pushed corals and their dinoflagellate symbionts above their thermal tolerance. This has resulted in episodes of mass coral bleaching that have increased in frequency and intensity since they were first reported in the scientific literature in

1979 (see reviews by Brown 1997, Hoegh-Guldberg 1999, Hoegh-Guldberg et al. 2007; Baker et al. 2008). Coral bleaching (Figure 2) occurs when the symbiosis between corals and their critically important dinoflagellate symbionts breaks down. These symbionts provide most of the energy needs of the coral host. The breakdown of the symbiosis can occur for a number of reasons, the major one of which is heat stress. The result of the breakdown of the symbiosis is that the brown dinoflagellate symbionts leave the otherwise translucent coral tissue, leaving corals to remain as a stark white colour (hence the term ‘bleached’). Without their energy source, bleached corals are susceptible to starvation, disease and death.

Figure 2 **A. Coral reef after experiencing mass coral bleaching (Great Keppel Island, southern Great Barrier Reef). B. Close-up of bleached coral showing intact but translucent tissues over the white skeleton. Photos by O. Hoegh-Guldberg, January 2006.**

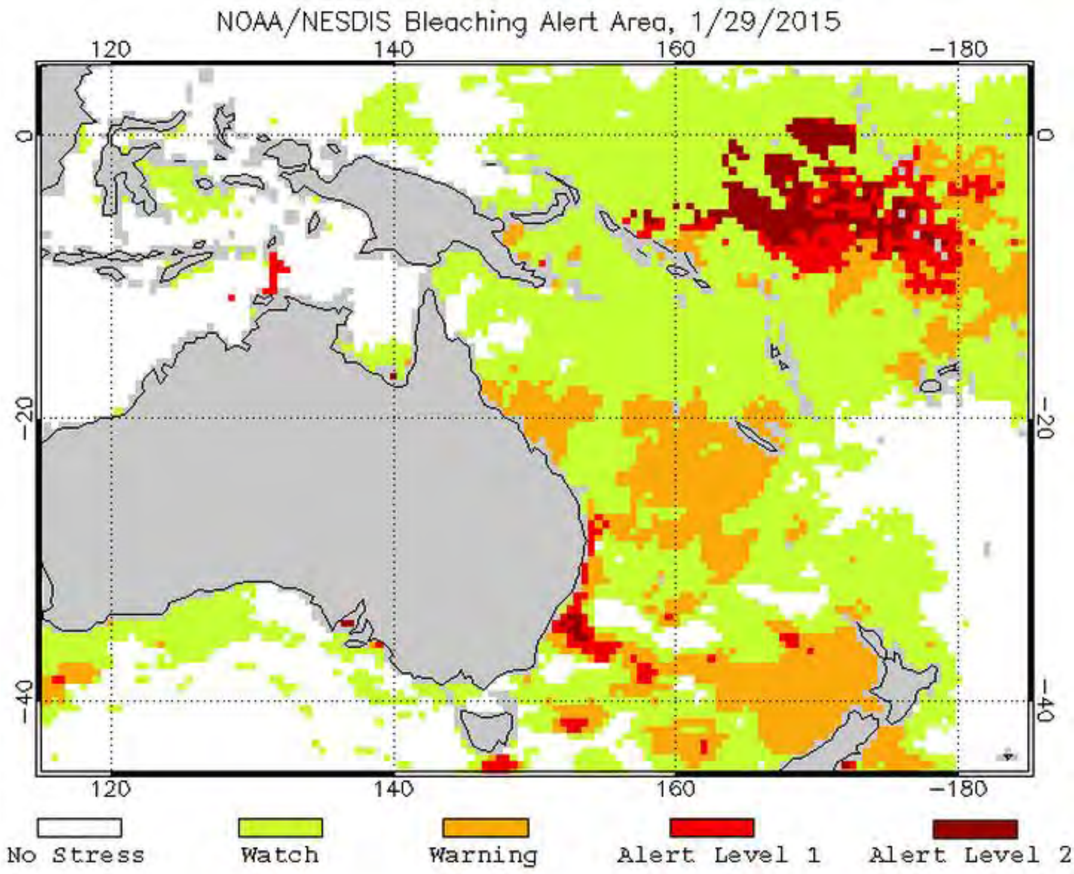


21. In 1998, most coral reefs worldwide experienced mass coral bleaching over a 12 month period that began in the eastern Pacific in December 1997. While many coral reef communities recovered from the subsequent 12 month period of extremely warm sea temperatures (driven by an unusually strong El Niño disturbance on top of the steadily rising sea temperatures globally), many coral reefs such as those in the Western Indian Ocean, Okinawa, Palau and Northwest Australia were devastated by the mass mortality which followed these bleaching events. In these cases, coral bleaching was followed by mass mortalities that removed over 90% of the resident corals on these reef systems. At the end of the 12 month period, bleaching across the globe had removed an estimated 16% of the world's coral (Hoegh-Guldberg 1999). Whereas some of these reefs have begun to recover, recovery has been exceedingly slow and coral cover on many of these reefs does not resemble that seen prior to 1998 (Wilkerson 2004).

22. The Great Barrier Reef has been affected by coral bleaching as a result of heat stress six times over the past 25 years. Recent episodes (i.e. 1998, 2002) on the Great Barrier Reef have been the most intense and widespread. In 1998, the Great Barrier Reef experienced what was considered at the time as its worst case of mass coral bleaching. In this event over 50% of the coral reefs within the Great Barrier Reef Marine Park were affected. This was followed, however, by an even larger event in 2002 which affected over 60% of the reefs with the Great Barrier Reef Marine Park. Fortunately in both cases, only 5–10% of corals affected by coral bleaching died, which was far less than the mortalities seen in regions such as the Western Indian Ocean, Okinawa or Northwest Australia (ranging up to 46%; Hoegh-Guldberg 1999). The latter was primarily because conditions on the Great Barrier Reef did not get as hot for as long as that seen in Western Indian Ocean or Northwest Australia. It is significant that climate change is now recognised as 'the greatest long-term threat to the Great Barrier Reef' (GBRMPA 2014: 5-5).

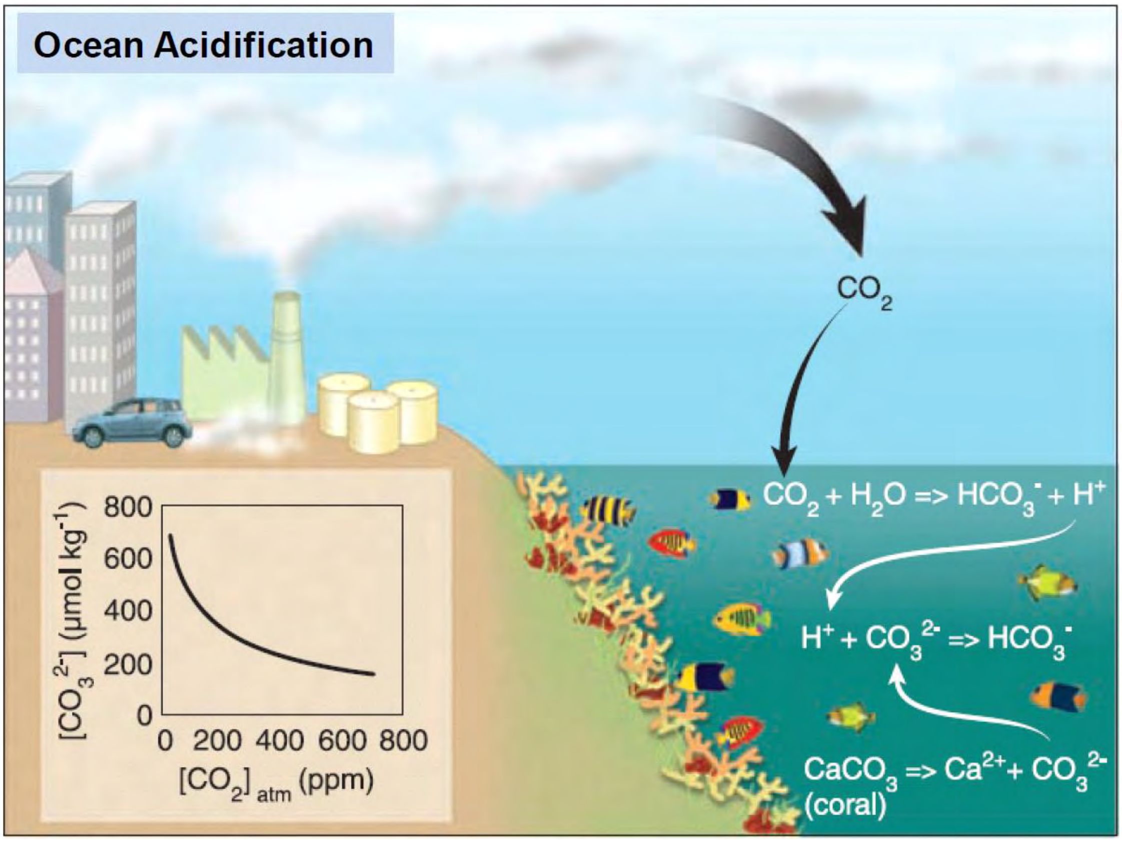
23. Sea temperatures in early 2015 have begun to approach the thermal threshold above which mass coral bleaching and mortality will occur. Over the past months, the temperature of water bathing the Great Barrier Reef has been steadily approaching the temperatures (at which mass coral bleaching and mortality is likely to occur). In the Figure 3 below from NOAA in Washington DC (http://coralreefwatch.noaa.gov/satellite/baa.php), bleaching has been reported from areas that are red in colour. Areas that are green and orange are areas in which temperatures are just below the bleaching threshold - but are considered to be under "watch" and "warning" levels. The risk of bleaching will continue to grow in these areas over the next two months unless cyclonic conditions develop, which would otherwise cool water due to increased mixing by the storm conditions. While these levels of natural variability might not have caused mass coral bleaching and mortality in the past, the increase in the background temperature of the ocean has meant that these small upward increases in sea temperature now drive an increasing frequency and intensity of mass coral bleaching and mortality are.

Figure 3 **NOAA/NESDIS bleaching alert area as at 29 January 2015**



24. The changes to water chemistry arising from ocean acidification, are adding additional pressure on coral reefs. As noted above, increasing concentrations of atmospheric carbon dioxide due to burning fossil fuels result in large quantities (approximately 30%) of additional carbon dioxide entering the ocean. Once in the ocean, carbon dioxide combines with water to produce a weak acid, carbonic acid, which subsequently converts carbonate ions into bicarbonate ions. This leads to a decrease in the concentration of carbonate ions, which ultimately limits the rate of marine calcification (Figure 4). A recent study has found a 14.5% decrease in the calcification rate of 328 long-lived corals on the Great Barrier Reef since 1990, which was unprecedented in the 400 years of record examined and appears to be a direct result of the changing temperature and sea water chemistry (De'ath et al. 2009). These long calcification records are possible because corals lay down distinct annual layers of calcium carbonate (much like tree rings), which in the case of long-lived corals, can lead to precise measures of yearly calcification going back hundreds of years.

Figure 4 **Schematic diagram showing the link between atmospheric carbon dioxide, ocean acidity and the calcification rates of coral reefs and other ecosystems. Insert diagram depicts relationship between atmospheric carbon dioxide (CO_2 atm) and ocean carbonate concentrations. (Reprinted courtesy of Science Magazine)**



25. While we are just starting to understand the impacts of ocean acidification on the Great Barrier Reef, there is consensus that the rate of change in the acidity of the ocean poses as great a threat to coral reefs as does global warming (Raven et al. 2005; Hoegh-Guldberg et al. 2007). This concern is heightened by the fact that current levels of ocean acidification may already lie outside those experience for the last million years at least (Pelejero et al. 2010). It is also important to note that ocean acidification and elevated temperature can also act synergistically making the effect of each factor more significant when they occur together, with thermal tolerance of reef-building corals to temperature being reduced when they are also exposed to ocean acidification at the same time (Anthony et al. 2008).

26. The combined pressure of local (i.e. deteriorating water quality) and global (ocean warming and acidification) have led to the loss of 50% of the corals on the Great Barrier Reef since the early 1980s (De'ath et al. 2012). In addition to increasing impacts from warmer than normal ocean temperatures (leading to mass coral bleaching and mortality) changing conditions have led to a reduced resilience of coral reefs to disturbances such as Crown of Thorns starfish (increasing due to added nutrients) and cyclone impacts.

IMPACTS AT CURRENT LEVELS OF CO_2

27. Prior to the beginning of the Industrial revolution, atmospheric concentrations of carbon dioxide (CO_2) were around 280 parts per million (ppm) (IPCC 2007). These concentrations have risen to approximately 400 parts per million (ppm) at present based on observations at the Mauna Loa observatory in Hawaii after season fluctuations are accounted for (NOAA 2015). Current rates of emissions of CO_2 from human activities are causing atmospheric CO_2 concentrations to rise by approximately 2 ppm per year (IPCC 2007, 2013). This rate of increase in atmospheric carbon dioxide is largely unprecedented. Even during the highest rates of change seen during the rapid transition out of the last ice age, the same amount of change we are currently experiencing in a single year occurred over 100-200 years. This transition was accompanied by massive changes to the Earth's climate and biosphere.

28. Temperature-induced mass coral bleaching began impacting coral reefs on a wide geographic scale in the early 1980s. Given that there is a lag time between the achievement of a certain level of atmospheric CO_2 and the resultant warming (conservatively estimated here as 10-20 years), impacts on coral reefs began atmospheric CO_2 levels approached ~320 ppm. When CO_2 levels reached ~340 ppm, sporadic but highly destructive mass bleaching occurred in most reefs world-wide, often associated with El Niño events. Recovery was dependent on the vulnerability of individual reef areas and on the reef's previous history and resilience. At today's level of ~400 ppm, allowing a lag-time of 10 years for sea temperatures to respond, most reefs world-wide are committed to an irreversible decline (Veron et al. 2009). The rate, extent and nature of this decline will become increasingly severe if atmospheric CO_2 concentrations continue to increase above current levels. Returning the atmosphere to a safe level of CO_2 for coral reefs requires atmospheric CO_2 concentrations of <350 ppm (Veron et al. 2009).

29. The GBRMPA found that optimum limits for coral reef ecosystems of atmospheric CO_2 are at or below 350 ppm (GBRMPA 2014: 5-5). It found further that there is already evidence of effects on the Reef at present levels of 400 ppm CO_2, such as declining calcification rates, that are suggested to be caused by temperature stress and ocean acidification and atmospheric concentrations of CO_2 above 450 ppm pose an extreme risk for coral reef ecosystems and tropical coastal habitats (GBRMPA 2014: 5-5).

30. This information suggests that the current 2°C guardrail may be too high for the majority of coral reefs (Donner et al. 2005; Veron et al 2009; Frieler et al 2012). Many reef users with long-term and extensive experience (e.g. Anthony Wayne Fontes; Lay Witness Statement) report that "many people that have visited the reef in the past, perhaps 10 years ago, when they returned they are actually shocked at the reduction in reef quality they see today."

31. Given the growing evidence that relatively small increases in the concentrations of atmospheric carbon dioxide will trigger a wide array of irreversible changes to critically important marine ecosystems, avoiding any further increases and aiming to reduce the atmospheric concentration of CO_2 below 350 ppm in the long term is seen by many experts as an international imperative (Veron et al 2009; Hoegh-Guldberg and Bruno 2010; Frieler et al 2012; IPCC 2014). Reducing the

atmospheric concentration of CO_2 to below 350 ppm is critical for preserving a safe climate system (Hansen et al. 2008, Rockström et al. 2009). Not pursuing this objective will escalate growing losses from a range of failing ecosystems and agriculture, increasing numbers of extreme events, and other health and societal impacts.

ASSUMPTIONS ABOUT FUTURE CLIMATE SCENARIOS

32. While current levels of atmospheric CO_2 are already detrimental for the Great Barrier Reef and other coral reefs globally, their continued existence in anything resembling their current form largely dependent upon the level at which atmospheric CO_2 is stabilised (Hoegh-Guldberg et al. 2007). It is important to realise that concentrations of greenhouse gases such as CO_2 above certain levels will mean that stabilisation of conditions, including those in the ocean, will not occur for hundreds if not thousands of years (IPCC 2013). This is likely to be highly disruptive to natural as well is human systems (IPCC 2015).

33. To project future increases in ocean warning and acidity requires assumptions to be made about future emissions of CO_2 and other greenhouse gases. It is unnecessary for the purposes of this report to make assumptions about the policies or technologies that must be employed to achieve emission reductions. It is sufficient for this report to discuss the physical consequences for the Great Barrier Reef if atmospheric CO_2 are stabilised or not at different atmospheric concentrations. The means by which stabilisation is achieved are policy matters that are unnecessary to consider for the purposes of this report. For the purposes of this report the following three basic scenarios are discussed based on the analysis in Hoegh-Guldberg et al. (2007) and Hoegh-Guldberg and Hoegh-Guldberg (2008):

Scenario	**Assumptions**
CRS-A	Atmospheric CO_2 is stabilised close to current levels of 390 ppm or up to approximately 420 ppm. Mean global temperature rises above pre-Industrial levels of approximately 1 – 1.5°C occur.
CRS-B	Atmospheric CO_2 is stabilised between 450 and 500 ppm. Mean global temperature rises above pre-Industrial values of approximately 2–2.5°C occur.
CRS-C	Atmospheric CO_2 is either not stabilised or is stabilised above 500 ppm at very long time horizons. Mean global temperature increase in above pre-Industrial levels of 2.5°C occur.

FUTURE CHANGES TO THE GREAT BARRIER REEF AS A RESULT OF CLIMATE CHANGE AND OCEAN ACIDIFICATION

34. Climate change and ocean acidification are placing coral reefs in conditions that they have not experienced over the past 740,000 years, if not 20 million years (Raven et al 2005; Hoegh-Guldberg et al 2007; Pelejero et al. 2010). Even the relatively rapid changes during the ice age transitions, which resulted in major changes in the biota of the planet, occurred at rates of change in CO_2 and temperature which were at least two orders of magnitude (i.e. one hundred times) slower than the rate of change that has occurred over the past 150 years. According to the latest IPCC report, there is scientific evidence that these changes are occurring at rates which dwarf even the most rapid changes seen over the past 65 if not 300 million years (IPCC 2014). Most evidence suggests that this rate of change will increase and already exceeds the biological capacity of coral reefs to respond via genetic change (evolution). As a result, there is a high degree of consensus within scientific circles that coral reefs, like a large number of other ecosystems, are set to undergo transformative and rapid changes over the coming decades (IPCC 2007, Done et al. 2003, Donner et al. 2005; IPCC 2014).

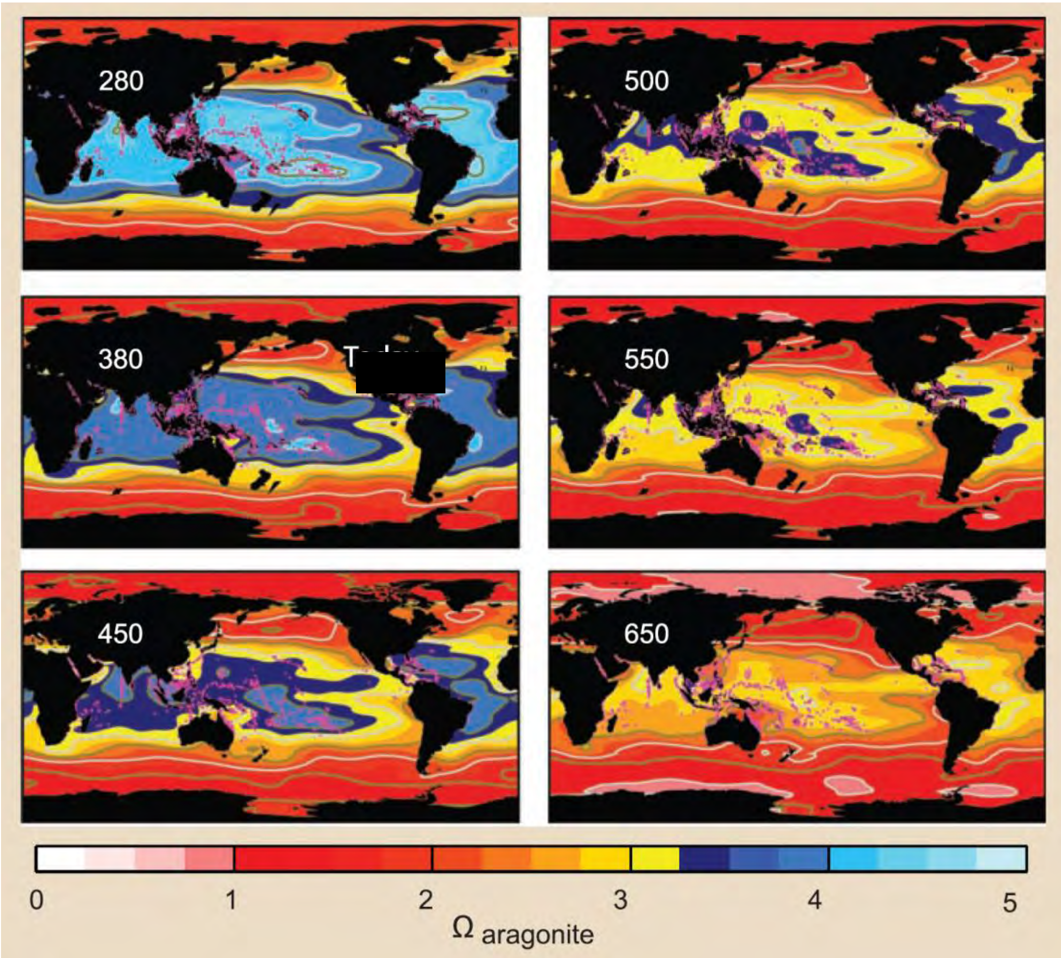
35. Consideration has recently been given to how reef systems like the Great Barrier Reef will change in response to changes in atmospheric gas composition. It is accepted that the environmental values of the Great Barrier Reef will continue to decline as average global temperature increase (page 5, Joint Report, Taylor and Meinshausen). In this regard, Hoegh-Guldberg et al. (2007) concluded that carbonate coral reefs such as the Great Barrier Reef are unlikely to maintain themselves beyond atmospheric carbon dioxide concentrations of 450 ppm. The evidence came from a wide array including field, laboratory and other sources. Neither temperature (+2°C above pre-industrial global temperatures) nor ocean carbonate concentration (<200 μmol kg^{-1}, which arise when $CO_{2\ atm}$ reaches approximately 450 ppm) in these scenarios are suitable for coral growth and survival, or the maintenance of calcium carbonate reef structures. These conclusions are based on the observation of how coral reefs behave today and how they have responded to the relatively mild changes in ocean temperature so far. Mass coral bleaching, for example, is triggered at temperatures that are 1°C above the long-term summer maxima which is the basis for highly successful satellite detection programs (Strong et al. 2004). Coral reefs also do not accrete calcium carbonate or form limestone-like coral reefs in water that has less than 200 μmol kg^{-1} carbonate ion concentrations (roughly equivalent to an aragonite saturation of 3.25; Kleypas et al. 1999). These conditions will dominate tropical oceans if carbon dioxide concentrations exceed 450 ppm (Figure 5).

36. Taking the two drivers together allows the scientific community to project how conditions on the Great Barrier Reef will change if atmospheric concentrations of carbon dioxide continue to increase. The critical point for carbonate coral reef systems like the Great Barrier Reef arises when carbon dioxide concentrations exceed 450 ppm. At this point, the majority of evidence points to tropical reef systems that do not have the dominant coral populations. As coral reefs are the results of vibrant coral communities, many of the services (e.g. fisheries, tourist use) are severely degraded at this point.

37. Using the evidence and conclusions of the Hoegh-Guldberg et al. (2007) study, in turn based on previous studies (Hoegh-Guldberg 1999, Donner et al. 2003, Hoegh-Guldberg and Hoegh-Guldberg 2003), three basic scenarios for the Great Barrier Reef can be assigned (Figure 6).

38. It is important that the three scenarios in Figure 6 be seen as representing a continuum of change and not a set of discrete thresholds or 'tipping points'. That said, it is also noteworthy that coral reefs regularly show non-linear behaviour (i.e. minimal change for a period and then a sudden and catastrophic decline in once-dominant species as an environmental variable changes, as described by Hughes (1995) and, hence, while we don't know where these 'breakpoints' exist relative to particular concentrations of atmospheric carbon dioxide, it is crucial to understand that there is a significant likelihood that ecosystems like the Great Barrier Reef might experience phase-transitions such as those already seen in the Caribbean and other coral reef realms (Hughes 1995).

Figure 5 **Calculated values for aragonite saturation, which is a measure of the ease with which calcium carbonate crystals (aragonite) form, as a function of geography. Coral reefs today only form where the aragonite saturation exceeds 3.25, which is illustrated by the blue coloured areas (coral reefs found today are indicated in this panel by the pink dots). As the concentration of carbon dioxide in the atmosphere increases from 390 ppm today, the extent of conditions that are suitable for the formation of carbon coral reefs dwindles until there are few areas with these conditions left at 550 ppm and above. Ocean acidification represents a serious threat to carbonate reef systems and may see the loss and decay of reef structures across the entire tropical region of the world (Reprinted courtesy of Science Magazine; Hoegh-Guldberg et al. 2007).**



39. In the case of minimal climate change (scenario CRS-A) atmospheric carbon dioxide stabilises at around current levels or up to 420 ppm, conditions surrounding the Great Barrier Reef will largely resemble those of today with the following important differences.

40. Firstly, mass coral bleaching events are likely to be more frequent and intense relative to those that have occurred over the past 25 years. Based on modelling studies (Hoegh-Guldberg 1999, Done et al. 2002, Donner et al 2003; IPCC 2014), mass coral bleaching events are likely to be twice as frequent as they are today if sea temperatures surrounding the Great Barrier Reef increased by another 0.55°C over and above today's temperatures. Changes in the sea temperature of this magnitude will also increase the intensity of the thermal anomalies which, depending on the particular phase of the El Niño Southern Oscillation and longer term changes in sea temperature such as the Pacific Decadal Oscillation (PDO), will result in large scale impacts on coral reefs like the Great Barrier Reef. This will result in a greater likelihood of mass mortalities among coral communities, and an overall downward adjustment of average coral cover on coral reefs like those in the Great Barrier Reef Marine Park (Hoegh-Guldberg et al. 2007). Some areas may lose coral permanently while others, such as those in well flushed and ecologically resilient locations (e.g. with good water quality, intact fish populations), are likely to remain coral dominated.

41. Secondly, there is likely to be a shift towards more degraded the three-dimensional reef frameworks as concentrations of carbonate ions decrease and become limiting for the calcifying activities of corals. The same time, organisms that dissolved and remove calcium carbonate appear to be stimulated (Dove et al. 2013). This may remove the habitat for some species (e.g. coral-dwelling fish and invertebrate species) while it may increase habitat for others (e.g. some herbivorous fish species). It is important to appreciate that reefs are likely to be populated by some form of marine life. Equally importantly, however, the replacement organisms (possibly seaweeds and cyanobacterial films) are unlikely to match (replace) the beautiful and charismatic coral reefs that we currently enjoy.

42. The importance of marine parks in protecting and maintaining conditions for coral reefs would be heightened as impacts from climate change and ocean acidification increase. Several studies have shown that the recovery of coral reefs (and hence their long-term sustainability) after climate change disturbances such as coral bleaching and mortality events is faster if the affected reefs are protected from local stresses like poor water quality and over exploitation of herbivorous fish (Hughes et al. 2003, Hughes et al. 2007).

43. If atmospheric CO_2 increases beyond 450 ppm, large-scale changes to coral reefs would be inevitable. Under these conditions, reef-building corals would be unable to keep pace with the rate of physical and biological erosion, and competition with other organisms, and coral reefs would slowly shift towards non-carbonate reef ecosystems. As with non-carbonate reef systems today, primary productivity and biodiversity would be lower on these transformed systems. Reef ecosystems at this point would resemble a mixed assemblage of fleshy seaweed, soft corals and other non-calcifying organisms, with reef-building corals being much less abundant (even rare). As a result, the three-dimensional structure of coral reefs would begin to crumble and disappear. Depending on the influence of other factors such as the

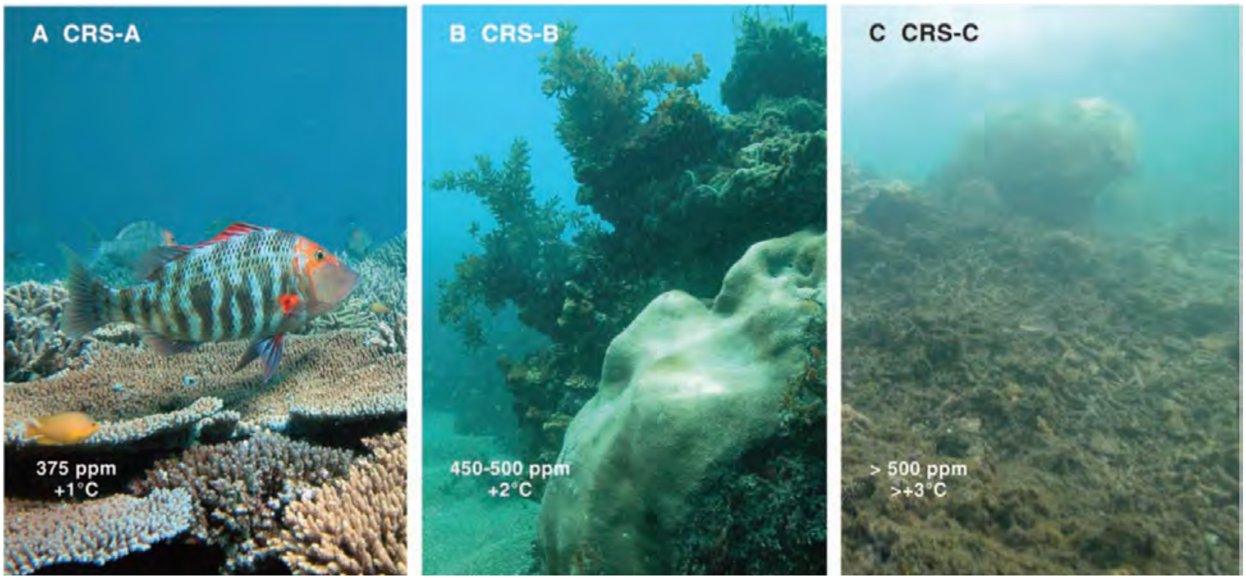
intensity of storms, this process may happen at either slow or rapid rates. It is significant to note that this has happened relatively quickly (over of an estimated 30 to 50 years) on some inshore sites on the Great Barrier Reef.

44. The loss of the three-dimensional structure has significant implications for other coral reef dwelling species such as populations where at least 50% of the fish species are likely to disappear with the loss of the reef-building corals and the calcium carbonate framework of coral reefs (Munday et al. 2007). Loss of the calcium carbonate framework would also have implications for the protection provided by coral reefs to other ecosystems (e.g. mangroves and sea grasses) and human infrastructure, as well as industries such as tourism which depends on highly biologically diverse and beautiful ecosystems. While coral reefs under this scenario would retain considerable biodiversity, their appearance would be vastly different to the coral reefs that attract tourists today (Figure 6B).

45. The rapid reduction in coral cover will have major consequences for other organisms and reef services and functions. Many organisms that are coral dependent will become rare and may become locally or globally extinct (Carpenter et al. 2008). Other organisms, such as herbivores, may actually increase as reefs change from coral domination to domination by algal/cyanobacterial organisms. Increases in the abundance of cyanobacteria may have implications for the incidence of poisoning by the toxin ciguatera, a major problem in some areas of the world already (Llewellyn 2010).

46. If the concentration of CO_2 in the atmosphere exceeds 500 ppm and conditions approach those of CRS-C, conditions will exceed those required for the majority of coral reefs across the planet (Figure 6C). Under these conditions, the three-dimensional structure of coral reef ecosystems like the Great Barrier Reef would be expected to deteriorate, with a massive loss of biodiversity, and ecological services and functions. Many of the concerns raised in a recent vulnerability assessment (Johnson and Marshall 2007) would become a reality, and most groups on the Great Barrier Reef would undergo major change. As argued by many other coral reef scientists (e.g. Hoegh-Guldberg et al. 2007; IPCC 2007, 2014), the increase in atmospheric carbon dioxide 500 ppm would result in scenarios where any semblance of reefs to the coral reefs of the Great Barrier Reef Marine Park today would vanish.

Figure 6 **A. If atmospheric carbon dioxide levels stabilise at current levels of 390 ppm up to around 420 ppm (scenario CRS-A), conditions will be similar to today except that mass bleaching events will be twice as common and will be more severe on reefs like the Great Barrier Reef. B. If atmospheric carbon dioxide concentrations that increase to around 450-500 ppm, together with a global temperature rise of 2°C above pre-Industrial levels, a major decline in reef-building corals is expected (reference scenario CRS-B). Because carbonate ion concentrations will fall below that required by corals to calcify and keep up with the erosion of calcium carbonate reef frameworks, reef frameworks will increasingly erode and fall apart. Seaweeds, soft corals and other benthic organisms will replace reef-building corals as the dominant organism on these much simpler reef systems. C. Levels of carbon dioxide in the atmosphere above 500 ppm, and associated temperature change (reference scenarios CRS-C) will be catastrophic for coral reefs which will no longer be dominated by corals or many of the organisms that we recognise today. Reef frameworks will actively deteriorate at this point, with ramifications for marine biodiversity, coastal protection and tourism (Reprinted courtesy of Science Magazine from Hoegh-Guldberg et al. 2007).**



47. Consistent with the available science, the GBRMPA has found that climate change is the most serious long-term risk facing the Great Barrier Reef and is likely to have far reaching consequences for the Region's environment (GBRMPA 2014: 11-6). The GBRMPA has also found that at present, global emissions are not on track to achieve the agreed global goal of limiting global temperature rises to beneath 2°C and even a 2°C rise would be a very dangerous level of warming for coral reef ecosystems, including the Great Barrier Reef, and the people who derive benefits from them (GBRMPA 2014: 11-6). The GBRMPA found that to ensure the Reef remains a coral-dominated system, the latest science indicates global average temperature rise would have to be limited to 1.2°C (GBRMPA 2014: 11-6).

CONTRIBUTION OF THE CARMICHAEL COAL MINE

48. I have been asked to specifically address how the emissions from the proposed Carmichael Coal Mine would influence the impacts of climate change and ocean acidification on the Great Barrier Reef and whether, in my opinion, the contribution of the mine to the impacts on the Great Barrier Reef is significant.

49. As we are already above the thermal threshold for damage to reef building corals and hence coral reefs, any further addition of CO_2 into the atmosphere will directly damage the Great Barrier Reef, its natural ecosystems and the future opportunities of people and businesses that depend upon its pristine and natural values. Even in 2015, temperatures are so warm that they are approaching the thermal threshold for mass coral bleaching and mortality (see Figure 3 above).

50. The thermal coal expected to be produced from the mine is estimated to be in excess of 2.326 Gt and the direct and indirect greenhouse gas emissions associated with the mine are 4.49 Gt CO_2 over the life of the mine according to the Joint Report of Dr Meinshausen and Dr Taylor.

51. Dr Meinshusen and Dr Taylor agree at paragraph 15 of their joint report that the remaining global carbon budget after 2015 is 850 Gt CO_2 for a likely chance (66% likelihood or greater) of keeping global mean temperature rises beneath 2°C. This global carbon budget and temperature rise is based on increasing atmospheric concentrations of CO_2 to approximately 450 ppm, which would be expected to result in severe damage to the Great Barrier Reef as I have explained above.

52. Given these facts, and the already very vulnerable state of the Great Barrier Reef to climate change and ocean acidification explained above, the contribution of the CO_2 emitted from the coal extracted from the mine over its lifetime represents a very significant contribution to the impacts being felt on the Great Barrier Reef and across a vast number of other ecosystems, agricultural and societal activities and concerns. The true cost of the emitted carbon from the Carmichael Mine to the Great Barrier Reef and other ecosystems, businesses and human health must be calculated and attached to any decision on whether or not to proceed with the mine. To ignore the impact of the mine, knowing that the emissions from the extracted coal are not going to be sequestered, ignores the much greater costs of the mine to people and businesses worldwide.

EXPERT'S STATEMENT – ADDITIONAL FACTS

I am not aware of any further readily ascertainable additional facts that would assist me to reach a more reliable conclusion.

DECLARATION

In accordance with rule 24F(3) of the *Land Court Rules 2000* (Qld), I confirm that:

(a) the factual matters stated in this report are, as far as I know, true; and

(b) I have made all enquiries considered appropriate; and

(c) the opinions stated in this report are genuinely held by me; and

(d) this report contains reference to all matters I consider significant; and

(e) I understand the duty of an expert the court and have complied with that duty; and

(f) I have read and understood the *Land Court Rules 2000* on expert evidence; and

(g) I have not received or accepted instructions to adopt or reject a particular opinion in relation to an issue in dispute in the proceeding.

Signed: ....
Professor Ove Hoegh-Guldberg

Date: **6 February 2015**

Address: **c/- Global Change Institute**
The University of Queensland
St Lucia Qld 4072

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APPENDIX 1

Curriculum vitae of Professor Ove Hoegh-Guldberg

OVE HOEGH-GULDBERG

GLOBAL CHANGE INSTITUTE

University of Queensland

NATIONALITY

Australian (born: 26/9/59, Sydney)

EDUCATION

1989	Ph.D. University of California, Los Angeles
1982:	B.Sc. (Hons, 1st class) University of Sydney

CURRENT POSITIONS

Director, Global Change Institute, University of Queensland (2010 –present)
Deputy Director, ARC Centre for Excellence for Reef Studies (2006-present)
Professor of Marine Studies, University of Queensland (2000-present)
Affiliated Researcher, Centre for Ocean Solutions, Stanford University (2008-present)

SIGNIFICANT APPOINTMENTS

2013-present	Fellow, Australian Academy of Science
2013-2014	Global Partnership for Oceans, Chair, Blue Ribbon Panel
2010-2014	Coordinating Lead Author, "Oceans" Chapter, 5th Assessment Report, Intergovernmental Panel on Climate Change (IPCC)
2012-present	Global Partnership for Oceans, Interim Committee member
2014-present	Chair, Technical Advisory Committee, Great Barrie Reef Foundation
2012-present	Chief Scientist, Catlin Seaview Survey
2001-2010	Visiting Professor, Stanford University
2001-2010	Director and Founder, Stanford Australia Marine Program, UQ
2010-2013	Senior Executive Management Committee, University of Queensland
2006-2012	Member, Board of Reviewing Editors, Science Magazine
2000-2009	Director and Founder, Centre for Marine Studies, University of Queensland
2001-2009	Chair, Climate Change and Coral health working group within CRTR project, Global Environmental Facility -World Bank (www.gefcoral.org).
2006-present	Member, Royal Society, London, Marine Advisory Network (MAN)
2004-present	Founding Member, Australian Climate Group now Climate Science Australia

2000-present: Member, International Scientific Advisory Committee, GBR Foundation
2004-2007 Member, Royal Society, London, Working Group on Ocean Acidification
2001-2005 Member, UNESCO-World Bank-IOC Synthesis Panel TRG Coral research.
2000-2009 Director, Heron Is, Low Isles and Morton Bay Research Stations
2002-2006 Member, Scientific Advisory Committee, QLD Gov committee on Biodiversity
1998 Visiting scientist, European Oceanographic Center, Monaco
1998 Research faculty, Indiana Institute of Molecular Biology
1995-1999 Director, One Tree Island Research Station
1993-1997 Director and Founder, Coral Reef Research Institute
1989-1991 Postdoctoral Fellow, Office of Naval Research, University of Southern California
1987-1991: Director and joint company founder, Sable Systems Pty Ltd
1983-1987: NAUI Dive Instructor, UCLA Dive School

HONORS AND AWARDS

2014	American Society of Microbiologists, ASM Lecturer for 2014
2013	ARC Laureate Fellowship (2013-2018)
2008	Queensland 2008 Smart State Premier's Fellow (2008 - 2013)
2011-2014	Highly Cited Researcher (Thomson Reuters, 4 years in a row)
2012	Citation Award Winner, Thomson Reuters Citation & Innovation Award (top-cited author: Highest cited author in Ecology)
2010	Thomson Reuters' ISI Highly Cited Researchers (most cited Australian scientist in the area of Climate Change, 3rd most cited internationally)
2009	Whitley Certificate of Commendation for book on Great Barrier Reef
2009	Thomson-Reuters' ISI Hot Paper Award.
2009	Wesley College Foundation (University of Sydney) Medal 2009
1999	The 1999 Eureka Prize for Scientific Research
1996	Sydney University Award for Excellence in Teaching
1989	Robert D. Lasiewski Award (for Ph.D., UCLA)
1988	UCLA Distinguished Scholar Award 1988
1987	Australian Museum/Lizard Island Bicentenary Fellowship
1987	Departmental Fellowship Award, UCLA
1984-88	Sydney University Traveling Scholarship (Ph.D. scholarship to U.S.)

INSTITUTE WEBSITE: WWW.GCI.UQ.EDU.AU

LAB WEBSITE: WWW.CORALREEFECOSYSTEMS.ORG

PROFESSIONAL SOCIETIES AND BOARD MEMBERSHIP

Science Magazine (Board of Reviewing Editors, 2006-2012)

Technical Advisory Committee, Great Barrier Reef Foundation (Chair, 2014-present)
Great Barrier Reef Foundation (International Scientific Advisory Committee; 2000-present)
Biodiversity Research Centre Academia Sinica, Taipei (Advisory Board; 2010 -present)
Leibniz Center for Tropical Marine Ecology, Bremen (Advisory Board; 2010 -present)
International Symbiosis Society (Governing Councilor, 2004-present)
Australian Coral Reef Society (Council 2000-2008; President; 2000-2002)
International Society for Reef Studies (Council; 2002-2008)

BIOGRAPHICAL SKETCH

Ove Hoegh-Guldberg is the Director of the Global Change Institute (www.gci.uq.edu.au), Deputy Director of the Centre for Excellence in Coral reef Studies (www.coralcoe.org.au) and Professor of Marine Science (www.coralreefecosystems.org) at the University of Queensland in Brisbane, Australia. Ove's research focuses on the impacts of climate change on marine ecosystems, and is one of the most cited authors on climate change with more than 15,000 citations from > 250 papers, books, and patents). He has also been a dedicated communicator of the threat posed by ocean warming and acidification to marine ecosystems, first raising the alarm with respect to seriousness of climate change for coral reefs in a landmark paper published in 1999. In addition to leading a research group at the University Queensland, he is the Coordinating Lead Author for the 'Oceans' chapter for the Fifth Assessment report of the Intergovernmental Panel on Climate Change. Working with Sir David Attenborough, Sylvia Earle, Tom Brokaw, Philippe Cousteau and many others, Ove has also sort to communicate crucially important scientific messages beyond the walls of academia. He has been awarded a Eureka Prize for his scientific research and a QLD Premier's fellowship, and is currently an ARC Laureate Fellow and member of the Australian Academy of Science. He shares his life with UQ marine biologist Associate Professor Sophie Dove and their two ocean enthusiast children, Fiona and Chris.

Access to report from Ove's term as Queensland Smart State Premier's Fellow can be found here (2008-2013; http://www.gci.uq.edu.au/images/uploads/publications/pf-report.pdf).

Refereed articles

Over 246 peer-reviewed publications (31 in Science, Nature or PNAS), with 56 since the beginning of 2012 together with over 30 peer-reviewed book chapters, research reports and 2 international patents. Publications include major contributions to physiology, ecology, environmental politics, and climate change. My most significant scientific contributions have been recognized recently through invited reviews by leading journals such as Science (Hoegh-Guldberg and Bruno 2010; Hoegh-Guldberg *et al.* 2007), major research funding (>$30 million since 2000; ARC Centre for Excellence, Queensland Smart State Premier's Fellowship; ARC Laureate Fellowship) and my appointment as Coordinating Lead Author of Chapter 30 ("The Oceans") for the 5th

Assessment Report of the Intergovernmental Panel on Climate Change. I am currently the most cited Australian author (and 3rd internationally out of 53,136 authors) on the subject of "climate change" according to the Thomson-Reuter's ISI Web of Science (2011, sciencewatch.com/ana/st/climate/authors). This represents a group of less than 0.5% of all published researchers in the world. I received a major award from Thomson Reuters in 2012 (Citation Award Winner in Ecology Thomson Reuters Citation & Innovation Award). My research publications have been cited over 24,209 times (Thompson-Reuters) and is cited over 2,000 times per year. My H-index is 55 (ISI 2011) or 67 (Google Scholar) and I have received several awards from Thomson-Reuters ISI Web of Science for papers that are among ISI's hottest paper (most cited over the past two years) in the both the area of "climate change" and "ocean acidification" (sciencewatch.com/ana/fea/09novdecFea/). In addition to my 115 peer-reviewed journal publications (29 in Science, Nature, PNAS) produced since 2006, I have also produced the edited book (Hutching, Kingsford and Hoegh-Guldberg, "The Great Barrier Reef", Springer/CSIRO Publishing; winner of a Whitley Award commendation in 2009) and 11 book chapters and refereed reports, and continue to hold 2 international patents (together Sophie Dove) on a novel class of Green Fluorescent Pigments. I have received several major prizes, including the UCLA Distinguished Scholar Award and the 1999 Eureka Prize for discovering the molecular mechanism (see below) behind mass coral bleaching and mortality (Hoegh-Guldberg and Jones 1999; Hoegh-Guldberg and Smith 1989a; Hoegh-Guldberg and Smith 1989b) and impact of global climate change on the earth's coral reefs (Hoegh-Guldberg 1999). These early discoveries shaped my career which has increasingly focused on the impact of global climate change on the marine ecosystems and the implications for people and societies (Hoegh-Guldberg *et al.* 2009). Recent awards include being in The Conversation's top ten articles in 2011 (http://theconversation.edu.au/the-conversations-top-ten-articles-in-2011-4929) and receiving a Thomson Reuters award a major citation award (top 12 scientists in Australia in "recognition of their outstanding contribution on research" (across all fields). http://ip-science.thomsonreuters.com.au/citation_innovation_awards_2012/).

LAND COURT OF QUEENSLAND

REGISTRY: Brisbane
NUMBERS: MRA428-14, EPA429-14
MRA430-14, EPA431-14
MRA432-14, EPA433-14

Applicant: **ADANI MINING PTY LTD**
AND

First Respondent: **LAND SERVICES OF COAST AND COUNTRY INC**
AND

Second Respondent: **CONSERVATION ACTION TRUST**
AND

Statutory Party: **CHIEF EXECUTIVE, DEPARTMENT OF ENVIRONMENT AND HERITAGE PROTECTION**

LAY WITNESS STATEMENT

I, Athony Wayne Fontes, dive operator in the Whitsunday region of the Great Barrier Reef, in the State of Queensland, sincerely and solemnly state that:

1. I have been a dive instructor trainer in the Witsundays since 1981, logged over 10,000 dives on the Great Barrier Reef and trained over 1,800 instructor candidates.
2. I have owned and operated a Professional Association of Diving Instructors (**PADI**) 5-Star Instructor Development Centre on the Great Barrier Reef for 15 years.
3. For nine years I was a member of the Great Barrier Reef Consultative Committee, which advised the Great Barrier Reef Marine Park Authority on the management of the Great Barrier Reef Marine Park.
4. I am currently chairman of the Whitsunday Local Marine Advisory Committee which advises the Great Barrier Reef Marine Park Authority on the local marine park issues.
5. I have a direct commercial interest in the ongoing health of coral reefs on the Great Barrier Reef and the tourism associated with the health of coral reefs in Queensland.

Witness statement
Filed on behalf of the First Respondent

Solicitor: Sean Ryan
Environmental Defenders Office (Qld) Inc
30 Hardgrave Road, West End, 4101
Telephone: (07) 3211 4466
Facsimile: (07) 3211 4655
Email: edoqld@edo.org.au

6. My statement is to be provided to Land Services of Coast and Country Inc for use in its objection to the proposed Carmichael Coal Mine.

Experience of climate change

7. Over the 34 years I have been diving on the Great Barrier Reef I have noted significant changes to the reef that I strongly believe are related to climate change.

8. The most notable change involves coral bleaching brought on by unusually high water temperatures. I have noted small, isolated coral bleaching events over a number of years (since the early 1980's) but the number of bleaching events has definitely increased over the years. As well, the duration of the events and the amount of coral bleached has increased. The most notable bleaching events occurred in the summers of 1998 and 2002. These bleaching events coincided with major bleaching events throughout the Great Barrier Reef as well as coral reefs around the world.

9. In both years, a number of our island dive sites and outer reef dive sites suffered a significant amount of bleaching but only a small amount of actual coral mortality.

10. As a result we had to shift to other primary dive sites, and there were less dive sites to choose from as a result of the widespread bleaching.

11. I have observed that the more experienced divers tend not return to my business after visiting lower quality dive sites.

12. A second possible impact on our region related to climate change is severe weather events, primarily cyclones. Over the years, we have had our share of cyclones in the Whitsunday region. Although very damaging to coral reefs, the reefs tended to bounce back in time. However, over the past decade and in particular, the last four years, the local reefs are not bouncing back as quickly as they have in the past. This is most obvious around the island reefs where two of the top three dive sites in the Whitsundays, Manta Ray Bay at Hook Island and Blue Pearl Bay at Hayman Island, were reduced to little more than coral rubble and show little recovery after four years.

13. These were also our prime dive sites.

14. The consequence of the destruction of the these island reefs has been a reduction in the number of dive sites available to my business.

Anticipated consequences of predicted climate change

15. If the predictions of climate change science, such as those set out in the most recent Intergovernmental Panel for Climate Change reports are accurate, I believe the effects of climate change on Great Barrier Reef tourism and in particular, diving and snorkelling, will be devastating.

16. The Great Barrier Reef is a World Heritage Area and I believe one of the best diving and snorkelling sites on the planet. Quite literally, divers and snorkellors come from around the world and Australia to visit the reef for

one reason; to see coral and fish. If there are no coral or fish, then there will be no people. If there is a significant reduction in the quality of the coral and fish then there will be a significant reduction in the number of visitors. In the Whitsundays, I have already heard visitors comment on the quality of reef, such as that it is not as colourful or vibrant as expected, or much of it looks dead, etc.

17. In my experience many people that have visited the reef in the past, perhaps 10 years ago, when they return they are actually shocked at the reduction in reef quality they see today.

18. If the climate science plays out as predicted, more bleaching events and more severe cyclones, the quality of the reef will drop way below visitor expectations and this will undoubtedly lead to a much reduced tourism market.

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Tony Fontes

Date: 20/11/14